CHINA RAILWAY DESIGN CORPORATION
КОСТЕ РАЦИНА 16б, 11000 БЕОГРАД
САОБРАЋАЈНИ ИНСТИТУТ ЦИП д.о.о.
11000 БЕОГРАД, НЕМАЊИНА 6/IV
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2/1.1.3.2.1 НАСЛОВНА СТРАНА

2/1. ПРОЈЕКАТ КОНСТРУКЦИЈА

Инвеститор:	„Инфраструктура Железнице Србије“ а.д. Немањина 6/4, Београд
Наручилац:	Конзорцијум фирми: China Railway International Corporation Ltd. China Communication Construction Company Ltd. (CCCC)
Објекат:	Пруга Београд - Суботица државна граница (Келебија), **ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА),** у Новом Саду, Кисачу, Степановићеву, Змајеву, Врбасу, Ловћенцу, Малом Иђошу, Бачкој Тополи, Жеднику, Наумовићеву и Суботици, К.О. Нови Сад I, К.О. Нови Сад IV, К.О. Кисач, К.О. Руменка, К.О. Степановићево, К.О. Ченеј, К.О. Бачко Добро Поље, К.О. Врбас, К.О. Врбас - град, К.О. Змајево, К.О. Куцура, К.О. Ловћенац, К.О. Мали Иђош, К.О. Фекетић, К.О. Бачка Топола, К.О. Бачка Топола - Град, К.О. Мали Београд, К.О. Биково, К.О. Доњи Град, К.О. Жедник, К.О. Нови Град, К.О. Палић, К.О. Стари Град, на катастарским парцелама према списку приложеном у Главној свесци
Врста техничке документације:	**ПГД-** Пројекат за грађевинску дозволу
Назив и ознака дела пројекта:	**2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03**
За грађење / извођење радова:	Нова градња
Пројектант:	China Railway Design Corporation Serbia Ogranak Beograd Косте Рацина 16б 11000 Београд, Србија
Одговорно лице пројектанта:	Генерални директор: 耿欣 (Генг Ксин)
Потпис:	XIN GENG Digitally signed by XIN GENG Date: 2021.08.03 09:43:10 +02'00'
Одговорни пројектант:	Зоран Луковић, дипл. грађ. инж. Лиценца број: 310 3032 03
Потпис:	ЗОРАН ЛУКОВИЋ 011041396 Sign Digitally signed by ЗОРАН ЛУКОВИЋ 011041396 Sign Date: 2021.08.01 17:49:33 +02'00'
Број дела пројекта:	2020-001-ГС-2/1.1.3.2
Место и датум:	Београд, април 2021.год.

CeS.TRA

ТЕХНИЧКА КОНТРОЛА ПРОЈЕКТА ЗА ГРАЂЕВИНСКУ ДОЗВОЛУ

2/1.1.3.2 ПРОЈЕКАТ ПОТПОРНИХ ЗИДОВА УЗ ГАЛЕРИЈУ НА km 78+377.03

Објекта: Пруга Београд - Суботица - државна граница (Келебија), **ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)**, у Новом Саду, Кисачу, Степановићеву, Змајеву, Врбасу, Ловћенцу, Малом Иђошу, Бачкој Тополи, Жеднику, Наумовићеву и Суботици, К.О. Нови Сад I, К.О. Нови Сад IV, К.О. Кисач, К.О. Руменка, К.О. Степановићево, К.О. Ченеј, К.О. Бачко Добро Поље, К.О. Врбас, К.О. Врбас - град, К.О. Змајево, К.О. Куцура, К.О. Ловћенац, К.О. Мали Иђош, К.О. Фекетић, К.О. Бачка Топола, К.О. Бачка Топола - Град, К.О. Мали Београд, К.О. Биково, К.О. Доњи Град, К.О. Жедник, К.О. Нови Град, К.О. Палић, К.О. Стари Град, на катастарским парцелама према списку приложеном у Главној свесци, на основу Закона о планирању и изградњи („Службени гласник РС” бр. 72/09, 81/09 – исправка, 64/10 – одлука УС, 24/11, 121/12, 42/13 – одлука УС, 50/13 – одлука УС, 98/13 – одлука УС, 132/14, 145/14, 83/18, 31/19, 37/19 - др. Закон, 9/20 и 52/21) и одредби Правилника о садржини, начину и поступку израде и начину вршења контроле техничке документације према класи и намени објеката (“Службени гласник РС”, бр. 73/2019), извршена је техничка контрола предметне документације, од стране предузећа CESTRA d.o.o. Београд.

ПРОЈЕКАТ СЕ ПРИХВАТА

Вршилац техничке контроле:	CESTRA d.o.o, Макензијева 57, Београд
Број лиценце:	351-02-03374/2020-09 од 18.03.2021.
Одговорно лице/Заступник:	Директор: Драган Милић, дипл.грађ.инж.

Потпис:

Вршилац техничке контроле:	Немања Шеловић дипл.грађ.инж.
Број лиценце:	310 P214 17

Потпис:

Број техничке документације:	A10312-61/21
Место и датум:	Београд, 2021.

2/1.1.3.2.2 САДРЖАЈ

2/1.1.3.2.1	Насловна страна	
2/1.1.3.2.2	Садржај	
2/1.1.3.2.3	Решење о одређивању одговорног пројектанта	
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Цртежи	Назив цртежа	Размера
2020-001-ГС-2/1.1.3.2.7.Ц01.	Основа	1:100
2020-001-ГС-2/1.1.3.2.7.Ц02.	Подужни пресек А-А	1:100
2020-001-ГС-2/1.1.3.2.7.Ц03.	Подужни пресек В-В и С-С	1:100
2020-001-ГС-2/1.1.3.2.7.Ц04.	Попречни пресек 1-1 и 2-2	1:100
2020-001-ГС-2/1.1.3.2.7.Ц05.	Попречни пресек 3-3 и 4-4	1:100
2020-001-ГС-2/1.1.3.2.7.Ц06.	Попречни пресек 3', 5', 6', 7'	1:100
2020-001-ГС-2/1.1.3.2.7.Ц07.	Попречни пресек 6'', 7'', 8'', 9''	1:100

2/1.1.3.2.3 РЕШЕЊЕ О ОДРЕЂИВАЊУ ОДГОВОРНОГ ПРОЈЕКТАНТА

На основу Члана 128, Закона о планирању и изградњи ("Службени гласник РС", бр. 72/09, 81/09-исправка, 64/10- одлука УС, 24/11, 121/12, 42/13-одлука УС, 50/13-одлука УС, 98/13-одлука УС, 132/14, 145/14, 83/2018, 31/2019, 37/2019 - др.закон и 9/2020) и одредби Правилника о садржини, начину и поступку израде и начину вршења контроле техничке документације према класи и намени објеката ("Службени гласник РС", бр. 73/2019) као:

О Д Г О В О Р Н И П Р О Ј Е К Т А Н Т

за израду **ПРОЈЕКТА КОНСТРУКЦИЈА - 2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03**, који је део ПГД - Пројекта за грађевинску дозволу за изградњу пруге Београд - Суботица државна граница (Келебија), **ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)**, у Новом Саду, Кисачу, Степановићеву, Змајеву, Врбасу, Ловћенцу, Малом Иђошу, Бачкој Тополи, Жеднику, Наумовићеву и Суботици, К.О. Нови Сад I, К.О. Нови Сад IV, К.О. Кисач, К.О. Руменка, К.О. Степановићево, К.О. Ченеј, К.О. Бачко Добро Поље, К.О. Врбас, К.О. Врбас - град, К.О. Змајево, К.О. Куцура, К.О. Ловћенац, К.О. Мали Иђош, К.О. Фекетић, К.О. Бачка Топола, К.О. Бачка Топола - Град, К.О. Мали Београд, К.О. Биково, К.О. Доњи Град, К.О. Жедник, К.О. Нови Град, К.О. Палић, К.О. Стари Град, на катастарским парцелама према списку приложеном у Главној свесци, одређује се:

Зоран Луковић, дипл.грађ.инж. _____310 3032 03

Пројектант:	CHINA RAILWAY DESIGN CORPORATION SERBIA OGRANAK BEOGRAD, Косте Рацина 16б
Одговорно лице/заступник:	Генерални директор: Генг Ксин, дипл.инж.
	Потпис:
Број техничке документације:	2020-001-ГС-2/1.1.3.2
Место и датум:	Београд, април 2021.год.

2/1.1.3.2.4 ИЗЈАВА ОДГОВОРНОГ ПРОЈЕКТАНТА

Одговорни пројектант пројекта **ПРОЈЕКТА КОНСТРУКЦИЈА - 2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03** који је део ПГД - Пројекта за грађевинску дозволу за изградњу пруге Београд - Суботица државна граница (Келебија), **ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)**, у Новом Саду, Кисачу, Степановићеву, Змајеву, Врбасу, Ловћенцу, Малом Иђошу, Бачкој Тополи, Жеднику, Наумовићеву и Суботици, К.О. Нови Сад I, К.О. Нови Сад IV, К.О. Кисач, К.О. Руменка, К.О. Степановићево, К.О. Ченеј, К.О. Бачко Добро Поље, К.О. Врбас, К.О. Врбас - град, К.О. Змајево, К.О. Куцура, К.О. Ловћенац, К.О. Мали Иђош, К.О. Фекетић, К.О. Бачка Топола, К.О. Бачка Топола - Град, К.О. Мали Београд, К.О. Биково, К.О. Доњи Град, К.О. Жедник, К.О. Нови Град, К.О. Палић, К.О. Стари Град, на катастарским парцелама према списку приложеном у Главној свесци:

Зоран Луковић, дипл. грађ.инж.

И З Ј А В Љ У Ј Е М

1. да је пројекат у свему у складу са издатим Локацијским условима:

-бр.ROP-MSGI-28188-LOCH-4/2020, Заводни број: 350-02-00031/2020-14 од 06.04.2020,

-бр.ROP-MSGI-28188-LOCH-4/2020, Заводни број: 350-02-00031/2020-14 од 07.04.2020 - Решење о исправци грешке,

-бр.ROP-MSGI-7141-LOC-1/2020, Заводни број: 350-02-00109/2020-14 од 08.05.2020,

-бр.ROP-MSGI-931-LOC-3/2020, Заводни број: 350-02-00192/2020-14 од 29.05.2020;

2. да је пројекат израђен у складу са Законом о планирању и изградњи, прописима, стандардима и нормативима из области изградње објеката и правилима струке;

3. да је пројекат у свему у складу са начинима за обезбеђење испуњења основних захтева за објекат прописаних елаборатима и студијама.

Одговорни пројектант:	Зоран Луковић, дипл. грађ. инж.
Број лиценце:	310 3032 03
	Потпис:
Број техничке документације:	2020-001-ГС-2/1.1.3.2
Место и датум:	Београд, април 2021.год.

2/1.1.3.2.5 ТЕКСТУАЛНА ДОКУМЕНТАЦИЈА

2/1.1.3.2.5.1 ТЕХНИЧКИ ОПИС

ТЕХНИЧКИ ОПИС

1. УВОД

Деоница пруге Нови Сад-Суботица-државна граница (Келебија) представља трећу деоницу пруге Београд-Суботица-државна граница (Келебија).

На новој траси двоколосечне пруге Нови Сад – Суботица - државна граница (Келебија), пројектованој за брзину од 200 km/h, је предвиђена изградња железничке галерије на стационажи км 78+401,27. На улазу и излазу из галерије предвиђене су прилазне потпорне конструкције. Потпорне конструкције обезбеђују стабилност пружног насипа у зони непосредно уз галерију.

2. САОБРАЋАЈНИ УСЛОВИ

У зони галерије налазе се четири колосека, три паралелна на доњем нивоу и један који их укршта на горњем нивоу. На доњем нивоу је двоколосечна пруга Нови Сад – Суботица као и једноколосечна пруга Нови Сад Путничка – Распутница Сајлово. На горњем нивоу је једноколосечна пруга Нови Сад Путничка – Распутница Сајлово.

Двоколосечна пруга Нови Сад – Суботица је на размаку од 4.75 м, док је трећи колосек удаљен 8.00 м од десног колосека двоколосечне пруге.

Угао укрштаја колосека на горњем и доњем нивоу је 16°.

3. ДИСПОЗИЦИЈА

Потпорна конструкција на улазу и излазу из галерије састоји се из две независне конструкције. Непосредно уз галерију, у зони највећих утицаја, предвиђена је рамовска конструкција, а у наставку потпорни зидови.

Рамовска конструкција формира рам од потпорног зида непосредно уз труп пруге горњег нивоа, попречних греда које прелазе преко двоколосечне пруге на улазу и једноколосечне пруге на излазу из галерије и стубова са друге стране пруге. Између вертикалних и хоризонталних елемената остварена је крута веза. Распони улазне и излазне рамовске конструкције диктирани су препреком преко које прелазе. На улазном делу рам прелази преко двоколосечне пруге и распон је 12.75 м. На излазном делу рам прелази преко једноколосечне пруге и распон је 8.00 м. Вертикални елементи су позиционирани тако да се налазе у истој оси са вертикалним елементима галерије.

Висина рама је дефинисана тако да су горње ивице попречних греда на истом нивоу са горњом површином галерије. Слободни профил за пролаз железничког саобраћаја је минималне висине од 6.65 м.

Дужина рамовске конструкција на улазу и излазу из галерије је 29.86 м. У наставку су предвиђени потпорни зидови.

Први зид налази се са леве стране пруге Нови Сад - Суботица од km 78+287.68 до km 78+316.52. Зид је у правцу укупне дужине 28.82m. Други зид налази се са десне стране пруге Нови Сад - Суботица од km 78+483.15 до km 78+504.78. Зид је у правцу укупне дужине 21.62m. Висина зидова формирана је тако да прати косину насипа пруге изнад њега.

4. КОНСТРУКТИВНИ ЕЛЕМЕНТИ

Уз труп пруге (лева страна) налазе се потпорни зид, темељна плоча и два реда шипова повезани у круту целину. На десној страни предвиђени су еквидистантно постављени стубови. Врх стубова је круто повезан са лежишном гредом а дно стубова са темељном гредом. Шипови су у једном реду. Лева и десна страна рама повезана је попречним гредама постављеним директно изнад стубова. На овај начин формирана је крута, просторна једнораспонска конструкција.

Зид

Зид се налази непосрено уз труп пруге. Дужина зида је 29.86 м. Целом дужином је константне висине 9.35 м и константне дебљине 1.00 м. Надовезује се на зид галерије а у наставку иду независни потпорни зидви.

Темељна плоча

Темељна плоча је дужине 29.36 м. Ширина темељне плоче је 5.60 м а дебљина константна целом дужином и износи 1.50 м.

Шипови испод темељне плоче

Испод темељне плоче предвиђени су шипови у два реда на попречном и подужном размаку од 3.60 м . Дужина шипова је 20м. Укупно је предвиђено 2x8 = 16 ком.

Лежишна греда

Лежишна греда подужно повезује кружне стубове у горњој зони. Укупне дужине је 29.86 м. Димензије су : 1.00м ширина и 2.05 м висина.

Стубови

Стубови су кружни пречника 80 цм. Висина сваког стуба је 7.30 м. Постављени су еквидистантно на размаку од 3.60 м. Предвиђено је 8 кружних стубова.

Темељна греда

Темељна греда подужно повезује кружне стубове у доњој зони. Укупне дужине је 29.36 м. Димензије су : 1.80м ширина и 1.50 м висина.

Шипови испод темељне греде

Испод темељне греде предвиђени су шипови у једном реду на подужном размаку од 3.60 м . Дужина шипова је 15м. Укупно је предвиђено 1x8 = 8 ком.

Попречне греде

Попречне греде су круто повезане са зидом лево и лежишном гредом десно омогућавајући раму просторну стабилност. Димензија су 80x80 цм и постављене су изнад стубова на размаку од 3.60 м. Укупно је предвиђено 8 попречних греда.

Потпорни зидови

Димензије зидова као и њихов облик су усвојене тако да задовољавају критеријуме стабилности и носивости а у складу са геомеханичким подацима на тој локацији.

Леви зид се састоји од 4 кампаде дужине 7.2m. Укупна дужина зида је 28.82m.Код кампада 1 и 2 темељ је ширине 4.2m. У попречном смислу темељ је правоугаоног облика

висине 100cm са зубом 100x100cm. Код кампада 3 и 4 темељ је ширине 5.6m ослоњен на по 4 шипа на свакој кампади. Осовинско растојање међу шиповима је 3.6m. У попречном смислу темељ је правоугаоног облика висине 1.5m. Вертикала зида са унутрашње стране је у нагибу 20:1. Ширина круне је 1.0m. У подужном смислу темељ је хоризонталан а висина зида се креће од 2.00m до 4.03m за кампаде 1 и 2 а за кампаде 3 и 4 од 4.53m до 6.73m.

Десни зид се састоји од 3 кампаде дужине 7.2m. Укупна дужина зида је 21.62m. Кампаде 5 и 6 су фундиране на шиповима дужине 14м. Фундирање за кампаду 7 је остварено на мин 1.80m од површине терена. Код кампаде 7 темељ је ширине 4.2m. У попречном смислу темељ је правоугаоног облика висине 100cm са зубом 100x100cm. Код кампада 5 и 6 темељ је ширине 5.6m ослоњен на по 4 шипа на свакој кампади. Осовинско растојање међу шиповима је 3.6m. У попречном смислу темељ је правоугаоног облика висине 1.5m. Вертикала зида са унутрашње стране је у нагибу 20:1. Ширина круне је 1.0m. У подужном смислу темељ је хоризонталан а висина зида се креће од 6.73m до 4.53m за кампаде 5 и 6 а за кампаду 7 од 4.03m до 2.52m.

5. ФУНДИРАЊЕ

Обзиром на геолошки састав и носивост тла, на присуство подземне воде, а у сагласности са геолошко геотехничким елаборатом, извршено је дубоко фундирање, а усвојену коту фундирања шипова треба да потврди геотехничар приликом ископа. Усвојено је фундирање на бушеним шиповима Ø120cm.

Фундирање је предвиђено на шиповима дужине 20 и 15m.

Обзиром на састав тла, шипови ће носити и по бази и по омотачу. Дубина и број шипова је димензионисан тако да максимална сила у шипу буде мања од срачунате носивости шипа.

Код потпорних зидова фундирање за кампаде 1, 2 и 7 је остварено на мин 1.80m од површине терена. Кампаде 3, 4, 5 и 6 су фундиране на шиповима дужине 14m.

Испод темељних греда и плоча је предвиђен слој за изравнање од 10cm, од неармираног бетона C12/15.

6. СТАТИЧКИ СИСТЕМ

Конструкција је моделирана као просторни рам где су сви елементи круто везани. На шиповима су моделиране опруге у складу са геомеханичким параметрима како би се симулирало садејство тла. Од оптерећења су разматрана сопствена тежина, притисак тла, притисак услед воза на насипу, сеизмички притисак тла као и инерцијалне силе у конструктивним елементима услед сеизмичког дејства. Сви конструктивни елементи су димензионисани за најнеповољнију комбинацију оптерећења.

7. ОСТАЛИ РАДОВИ

Хидроизолација бетонских површина које су у контакту са земљом се врши помоћу једног хладног премаза битулитом и једног премаза врућим битуменом. Пре премазивања све површине морају бити очишћене и припремљене.

Бетонске површине које су изложене ваздуху обложити хидрофобичним премазом ради заштите од корозије која настаје услед дејства воде и соли.

На контакту зида рамовске конструкције са зидом галерије као и на контакту са потпорним зидовима предвиђене су еластичне спојнице типа "Фугебанд".

8. МАТЕРИЈАЛИ

Пројектом је предвиђено уграђивање бетона следећих карактеристика:

Зид	C30/37
Темељна плоча и греда	C30/37
Лежишна греда	C30/37
Стубови	C40/50
Попречне греде	C30/37
Шипови	C30/37
Потпорни зид	C25/30

Армирање се изводи арматуром B500B.

Квалитет уграђеног материјала мора одговарати важећим стандардима и пре уграђивања морају се приложити докази о квалитету материјала, без којих не сме почети уградња.

9. ТЕХНОЛОГИЈА ГРАДЊЕ

Ископ за темеље стубова и наглавне греде шипова се изводи плитко, машинским ископом темељних јама без посебне заштите. За извођење бушених шипова на осталим стубовима треба обезбедити приступ гарнитуре за бушење. Шипови се бетонирају до нивоа од мин 30 цм изнад врха шипа, с тим да на првом изведеном шипу надвишење буде мин 60 цм. При крајцовању “запрљаног“ бетона чувати постављену арматуру.

После постављања слоја подложног бетона, арматуре и оплате, изводе се темељи, наглавне греде шипова, зид и стубови, бетоном ливеним на лицу места уз потребну оплату. После ове фазе могуће је приступити делимичном затрпавању темеља.

Попречне греде се изводе на унапред припремљеној скели и оплати са бетоном ливеним на лицу места.

Након ових радова приступа се комплетном формирању насипа у залеђу зида.

Ископ темеља, армирање, бетонирање, израда дренажног система и насипање за потпорни зид ради се по кампадама од 7.2m дужине. Ископ темеља зида врши се за све кампаде одједном. Ископ се врши у категоријама II и III. Залеђину зида затрпати песком (угао унутрашњег трења $\varphi=30^0$) уз набијање тек по завршетку свих кампада потпорног зида.

Између кампада појављују се додирне спојнице. Додирне спојнице су назубљеног облика и имају гумену траку за заптивање ка земљи и троугаони вертикални утор 2 x 1,5 x 1,5cm споља.

Дилатационе спојнице треба предвидети на сваке две кампаде. Дилатационе спојнице се израђују у равном облику, ширине су 2cm и имају гумену траку за заптивање ка земљи,

завршну гумену траку или трајно еластичну масу за спојницу ка спољној страни зида и испуну споја (пенасту масу). Дилатационе и додирне спојнице смањују негативне утицаје реологије, температуре и промјенљивих особина темељног тла. Израђују се као водонепропусне.

Темељи и зидови се затрпавају водопропустним материјалом од песка, погодним за дренирање подземне воде. Кампаде зидова садрже испусте (барбакане) Ø50mm које пролазе кроз зидове и дренажу иза зида која се излива у канал. Дренажна цев је обложена филтером и геотекстилом како би се спречило филтрирање ситног материјала из песка.

Београд, Април 2021.

Одговорни пројектант:

Зоран Луковић, дипл.грађ.инж
лиценца бр.: 310 3032 03

2/1.1.3.2.6 НУМЕРИЧКА ДОКУМЕНТАЦИЈА

2/1.1.3.2.6.1 СТАТИЧКИ ПРОРАЧУН

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8.1.1.1. **Зид /** Wall

8.1.1.2. **Стуб /** Pier

8.1.2. **Контрола замора /** Fatigue check

8.1.2.1. **Зид /** Wall

8.2. Излаз / Exit

8.2.1. **Контрола прслина /** Crack check

8.2.1.1. **Зид /** Wall

8.2.1.2. **Стуб /** Pier

8.2.2. **Контрола замора /** Fatigue check

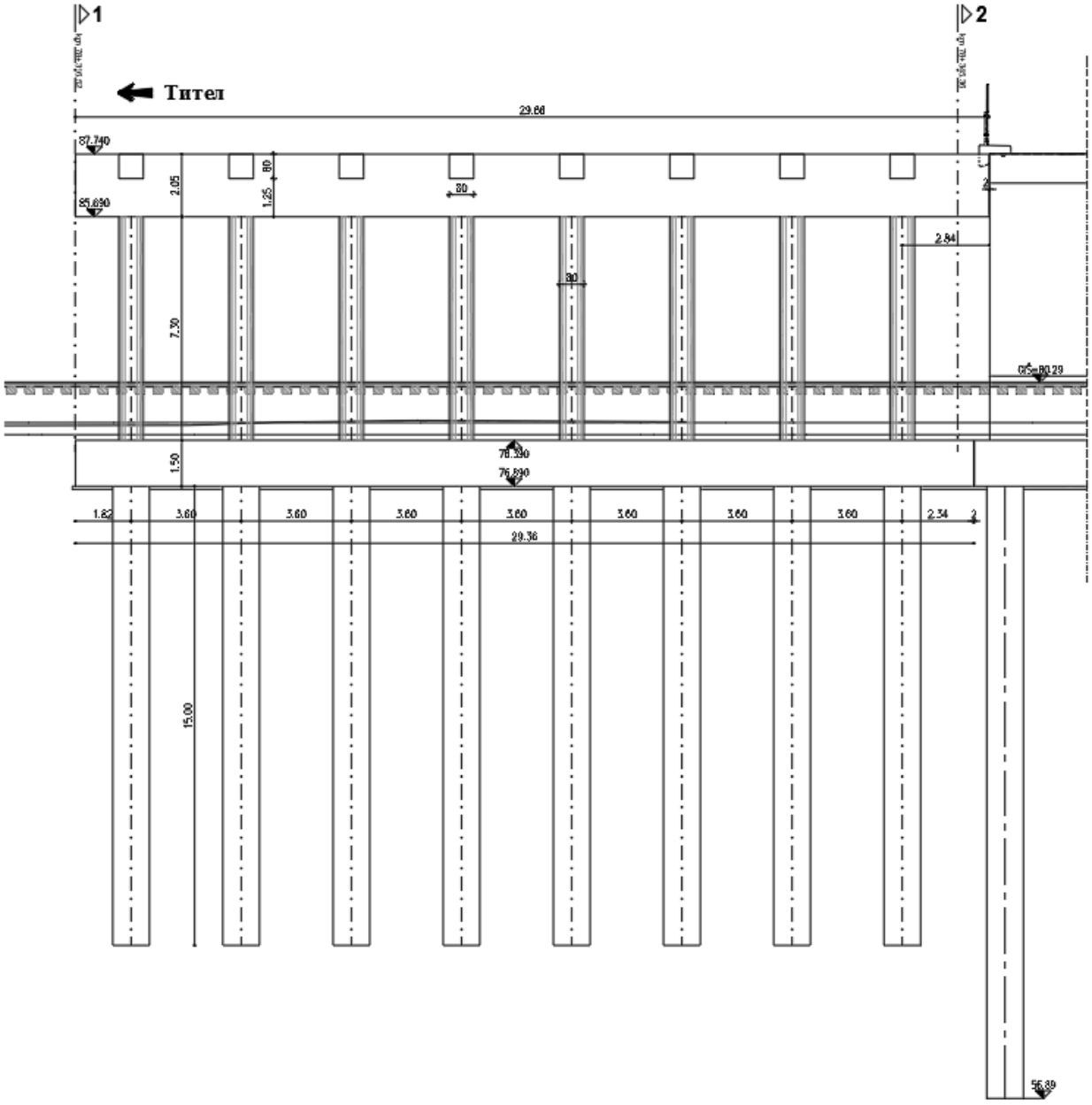
8.2.2.1. **Зид /** Wall

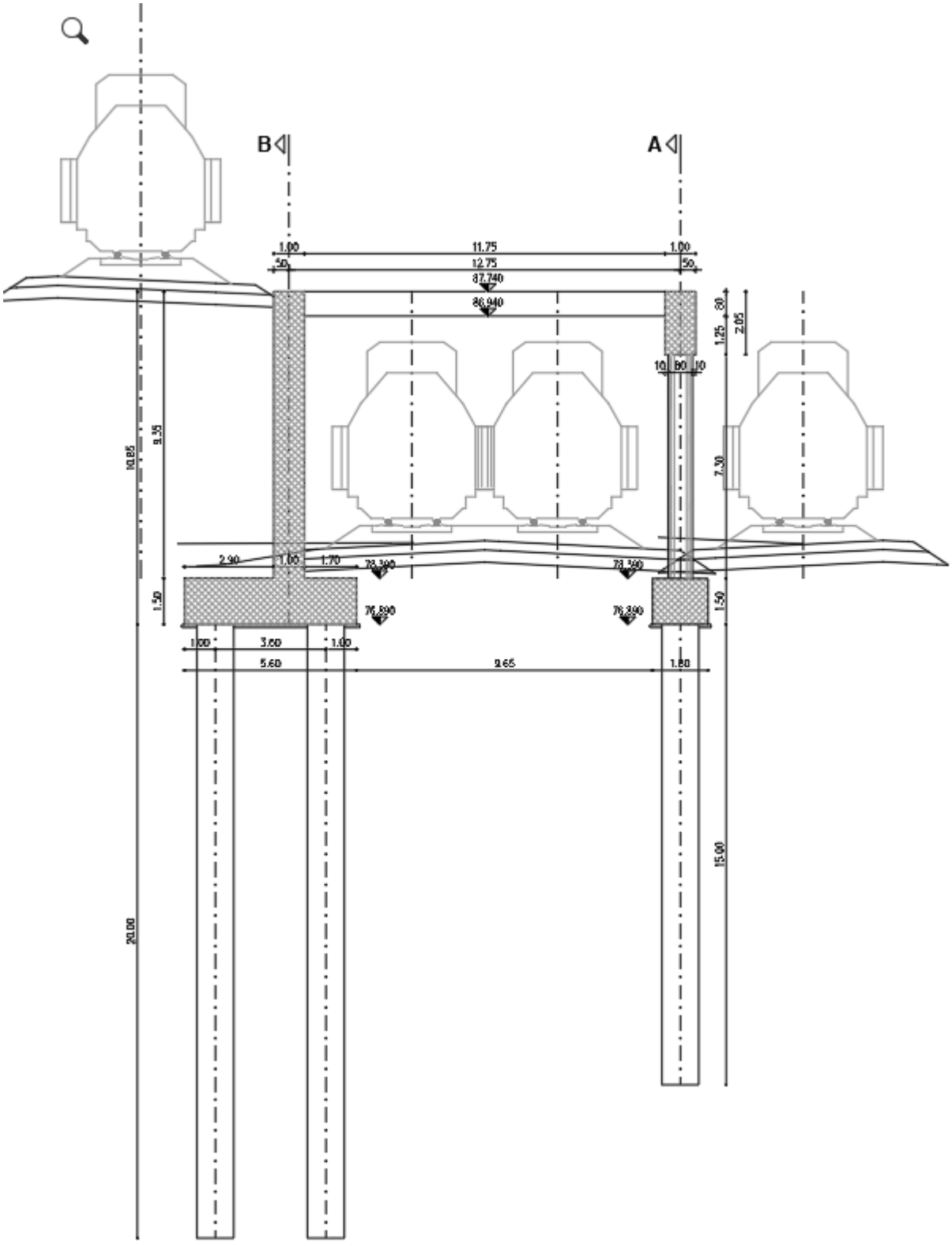
PRILAZNA KONSTRUKCIJA – GALERIJA 78+377

APPROACH STRUCTURE – GALLERY 78+377

1. **Диспозиција /** General arrangement

Улаз / Entrance

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.50
12.75
.50
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86.940
.80
1.25
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80
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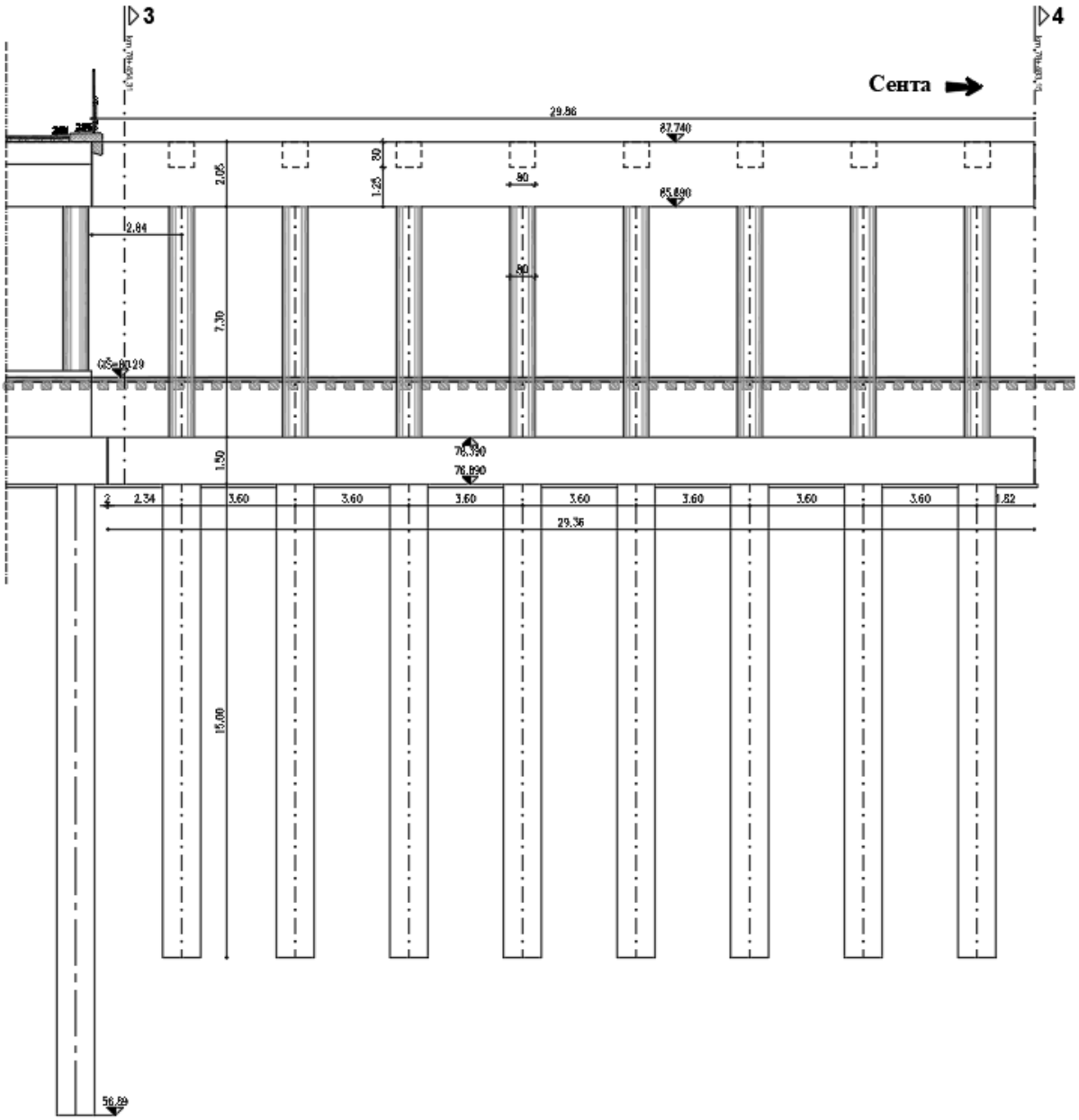
9.35
7.30
2.90
1.00
1.70
78.390
78.390
1.50
76.890
76.890
1.50
1.00
3.60
1.00
5.60
9.65
1.80
20.00
15.00

Излаз / Exit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4
Сента
29.86
87.740
2.05
1.25
80
85.890
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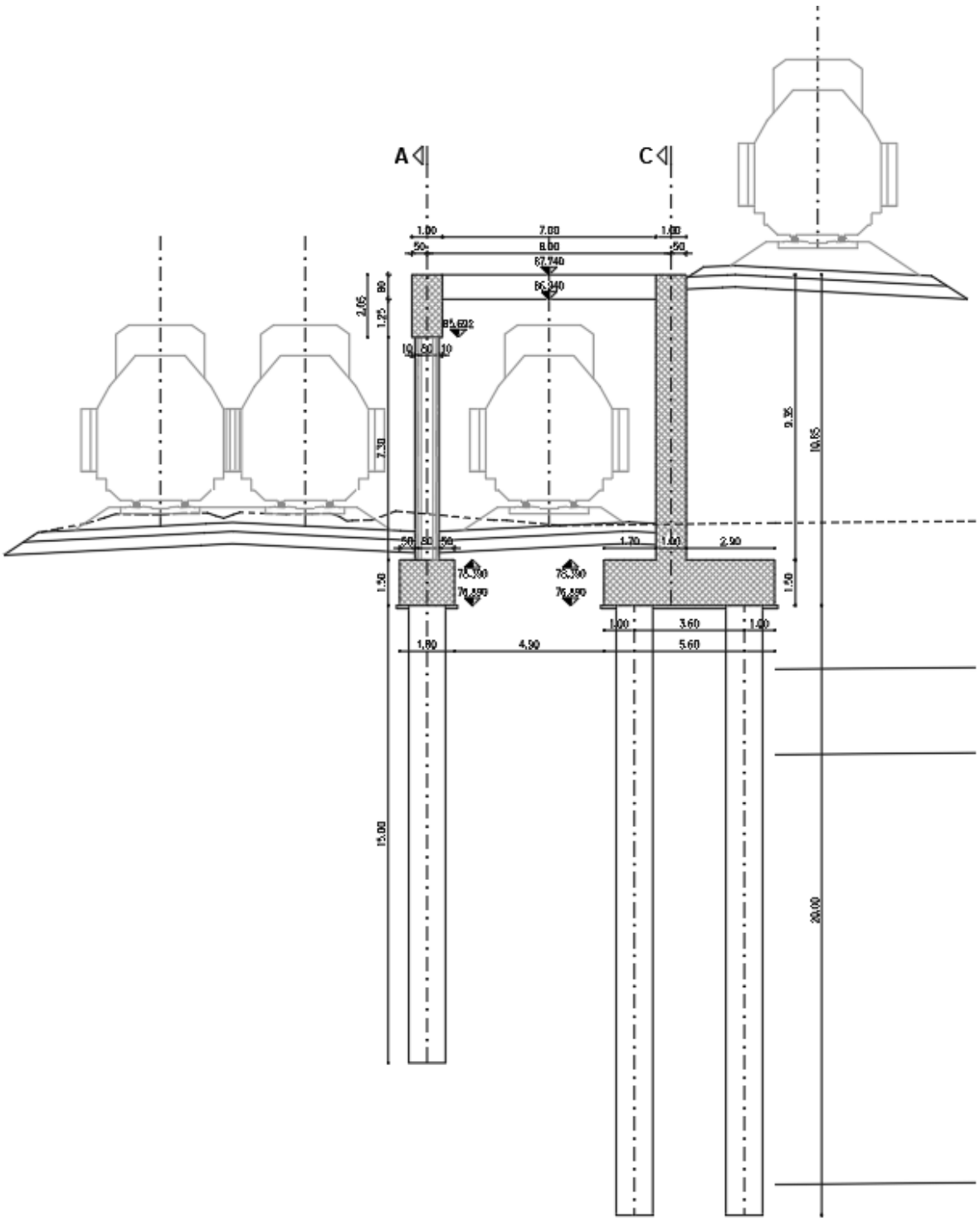
7.30
1.50
76.390
76.890
2
2.34
3.60
1.82
29.36
15.00
56.89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1.70
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2.90
1.50
1.50
1.00
3.60
1.00
1.80
4.90
5.60
15.00
20.00

2. **Анализа оптерећења /** Load analyses

2.1. **Сопствена тежина** / Self weight

Сопствена тежина свих елемената је узета у обзир у прорачуну аутоматски у програмском пакету.

Self weight of all elements will be taken into account automaticaly by design software.

Зид / Wall **,** d = 100 cm

Лежишна греда / *Bearing beam* **,** b**/**d = 100/205 cm

Попречна греда / *Cross beam* **,** b**/**d = 80/80 cm

Стубови / Piers , Φ80 cm

Темељна греда / Foundation beam, b**/**d = 180/150 cm

Темељ / Foundation , d = 150 cm

Шипови / Piles **,** Φ120 cm

2.2. **Притисак тла /** Earth pressure

Притисак тла у миру / earth pressure at rest

pzh = (1-sinφ) x γ x h = ko x γ x h

φ = 35

Прорачун по ULS-u / Design at ULS

tan φd = tanφk/γ_φ = tan35/1.25 = 0.46

φd = arctan0.46 = 24.79^o

ko = 1-sinφk = 0.581

γz = 20 kN/m3

Presek / Section 1-1

β = 30 ^{o}

h = 5.20 m

ph = γz x h x (1-sinφk) x (1-sinβ)

ph = 20 x 5.20 x 0.581 x 1.50 = 90 kN/m2

Presek / Section 2-2

β = 0 ^{o}

h1 = 0.70 m – **надслој** / overlay

h2 = 9.35+0.70 = 10.05 m

ph = γz x h x (1-sinφk) x (1-sinβ)

ph1 = 20.00 x 0.70 x 0.581 = 8 kN/m2

ph2 = 20.00 x 10.05 x 0.581 = 116 kN/m2

2.3. Воз на насипу / Train load on embankment

p = q(M71) x α x Φ3/b

q(M71) = 156,25 kN/m

α = 1,21

b – **ширина распростирања** / spreding length

za h = 0.70 m → b = 2.60 + 2x0.70/4 = 2.95 m

p = (156,25x1,21)/2.95 = 64 kN/m2

ph = 0.581x64 = 37 kN/m2

za h = 10.05 m → b = 2.60 + 2x0.70/4 + 2x9.35/2 = 12.30 m

p = (156,25x1,21)/12.30 = 15.40 kN/m2

ph = 0.581x15.40 = 9 kN/m2

2.4. Сеизмички притисак тла / Seismic soil pressure

Ks = 0.10 /2 = 0.05

$P_a = Ks \times \psi \times \gamma_z \times h^2 \times \frac{3 + 2 \times tg\beta}{4}$ - **сеизмичка сила** / seismic force.

$h_a^{'} = \frac{1}{12} \times \frac{15 + 8 \times tg\beta}{3 + 2 \times tg\beta} \times h$ - **крак силе** / position of force

Presek / Section 1-1

β = 30 o

h = 5.20 m

Pa = 21 kN/m

ha = 0.40 m

Presek / Section 2-2

β = 0 ^{o}

h2 = 9.35 m

Pa = 49 kN/m

ha = 3.90 m

2.5. Seizmičko dejstvo / Seismic load

Modal Analysis

Load factors for mass calculations

No	Name	Factor
1	Sopstvena tezina (g)	1.00
2	Pritisak tla	0.00
3	Voz na nasipu	0.00
4	Seizmicki pritisak tla	0.00

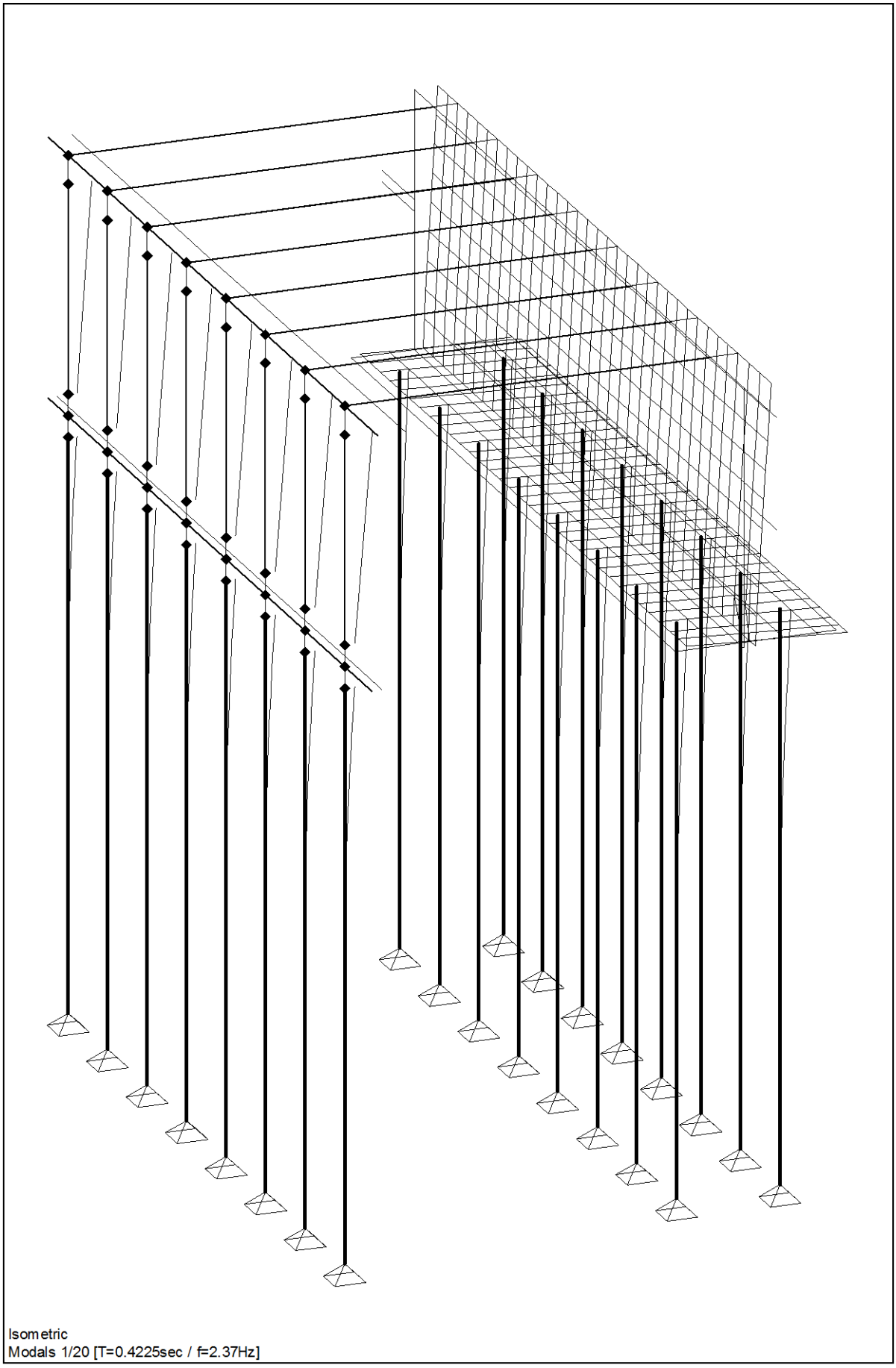
2.5.1. **Улаз** / Entrance

Mass distribution per levels

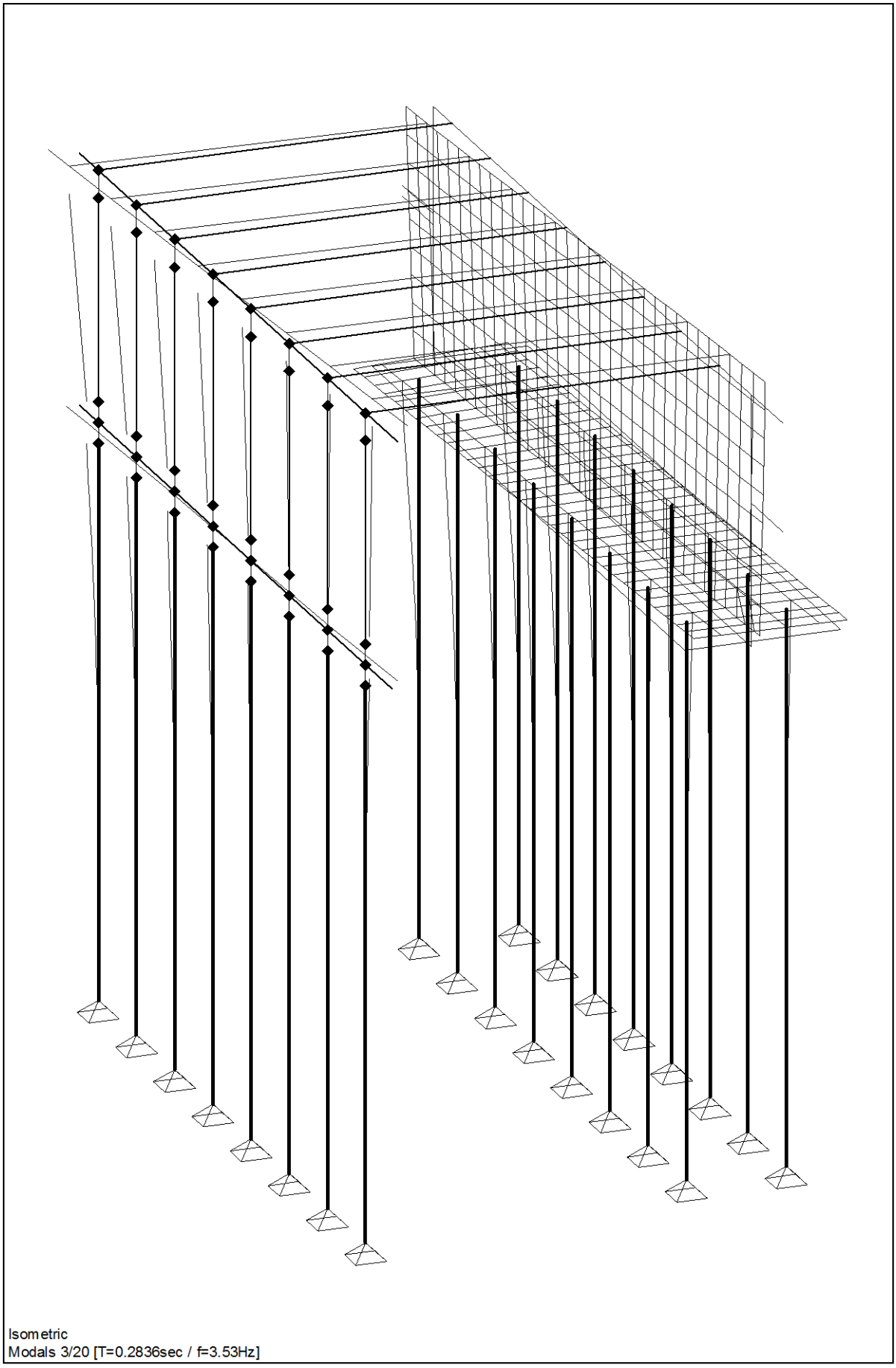
Level	Z [m]	X [m]	Y [m]	Mass [T]	T/m²
	0.00	14.83	7.75	706.68	
	-9.05	14.81	10.54	1218.25	7.37
Total:	-5.73	14.82	9.52	1924.93	

Natural frequency of structure

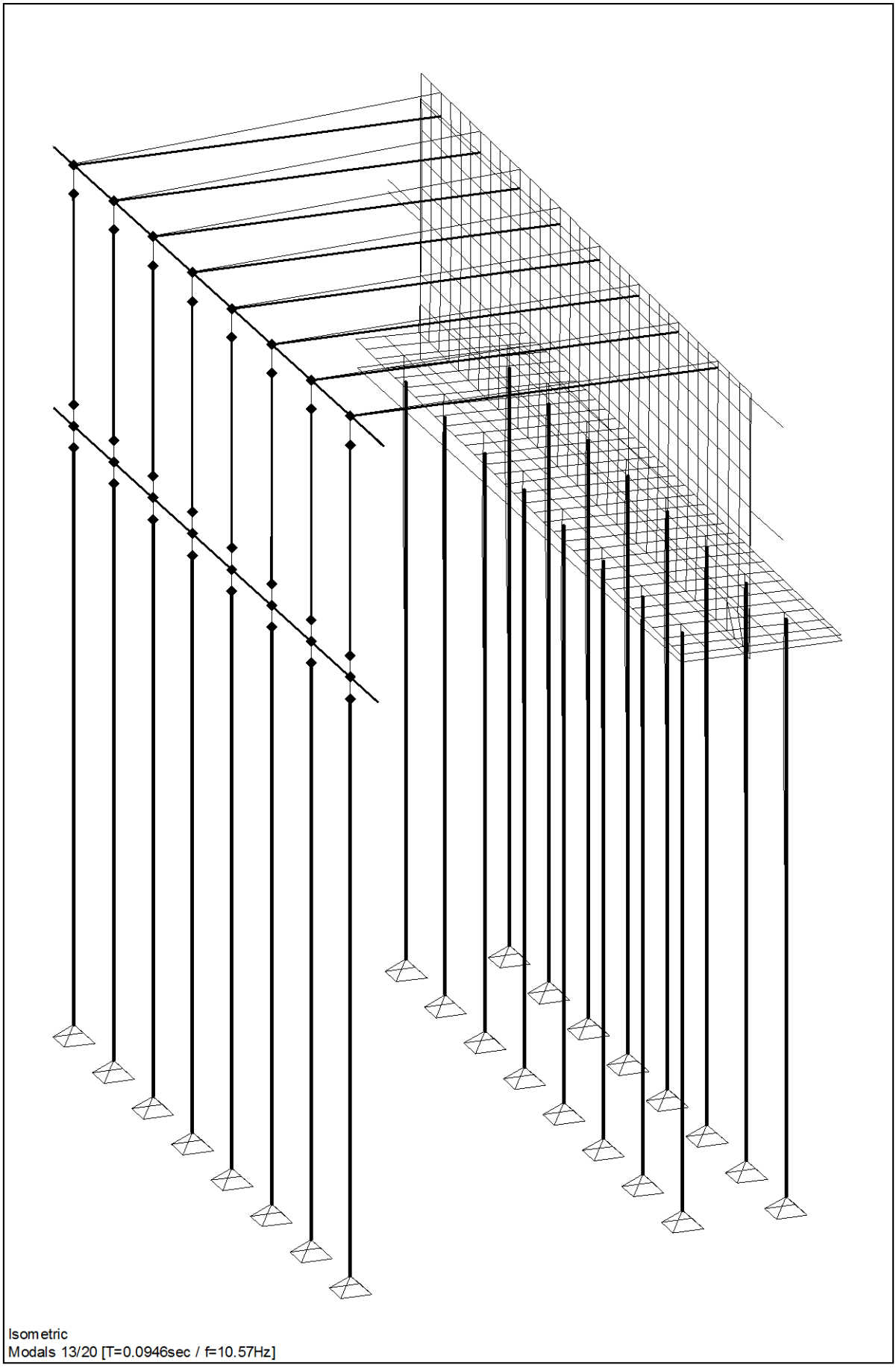
No	T [s]	f [Hz]
1	**0.4225**	**2.3671**
2	0.3399	2.9423
3	**0.2836**	**3.5265**
4	0.2451	4.0804
5	0.1616	6.1890
6	0.1498	6.6735
7	0.1371	7.2928
8	0.1249	8.0093
9	0.1235	8.0989
10	0.1185	8.4388
11	0.1022	9.7842
12	0.0999	10.0111
13	**0.0946**	**10.5668**
14	0.0855	11.6988
15	0.0810	12.3435
16	0.0699	14.3160
17	0.0692	14.4495
18	0.0528	18.9278
19	0.0515	19.4297
20	0.0466	21.4668



Isometric
Modals 1/20 [T=0.4225sec / f=2.37Hz]



Isometric
Modals 3/20 [T=0.2836sec / f=3.53Hz]



Isometric
Modals 13/20 [T=0.0946sec / f=10.57Hz]

Seismic analysis: EC8 (EN 1998)

Soil category:	C
Importance factor:	II (γ=1.0)
Ratio ag/g:	0.10
Dumping coefficient:	0.05

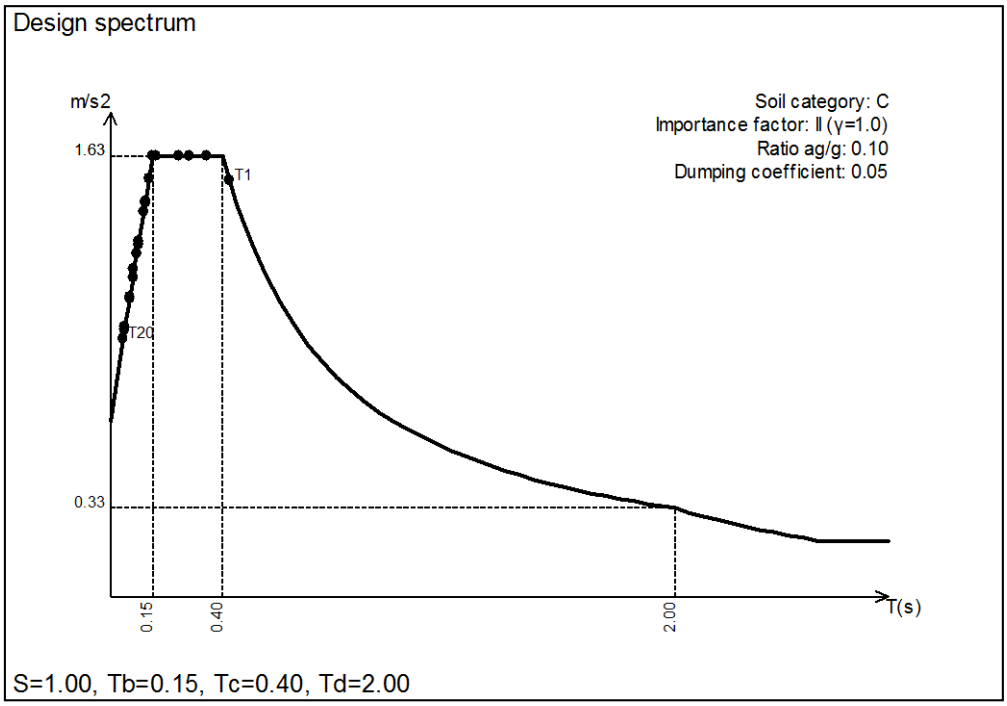
Earthquake directional factors:

Load case	Angle α[°]	k,α	k,α+90°	kz	q
Sx	0	1.000	0.000	0.000	1.500
Sy	90	1.000	0.000	0.000	1.500
Sz	0	0.000	0.000	1.000	1.500

Type of spectrum

Load case	S	Tb	Tc	Td	avg/ag
Sx	1.000	0.150	0.400	2.000	1.000
Sy	1.000	0.150	0.400	2.000	1.000
Sz	1.000	0.150	0.400	2.000	1.000

Design spectrum



S=1.00, Tb=0.15, Tc=0.40, Td=2.00

Distribution factors - mass involvement

Mode	U [α=0°]	U [α=90°]	U [α=0°]	U [Z]
1	0.01	84.38	0.01	0.03
2	11.13	0.29	11.13	0.00
3	69.55	0.02	69.55	0.00
4	12.80	0.00	12.80	0.00
5	0.00	1.93	0.00	0.00
6	0.01	0.48	0.01	0.00
7	0.00	12.24	0.00	0.01
8	2.99	0.12	2.99	0.00
9	2.47	0.14	2.47	0.00
10	0.00	0.04	0.00	0.00
11	0.87	0.01	0.87	10.18
12	0.00	0.02	0.00	0.00
13	0.10	0.04	0.10	64.55
14	0.03	0.00	0.03	11.59
15	0.03	0.00	0.03	12.77
16	0.00	0.00	0.00	0.56
17	0.00	0.00	0.00	0.00
18	0.00	0.01	0.00	0.00
19	0.00	0.00	0.00	0.00
20	0.01	0.00	0.01	0.01
ΣU (%)	100.00	99.72	100.00	99.71

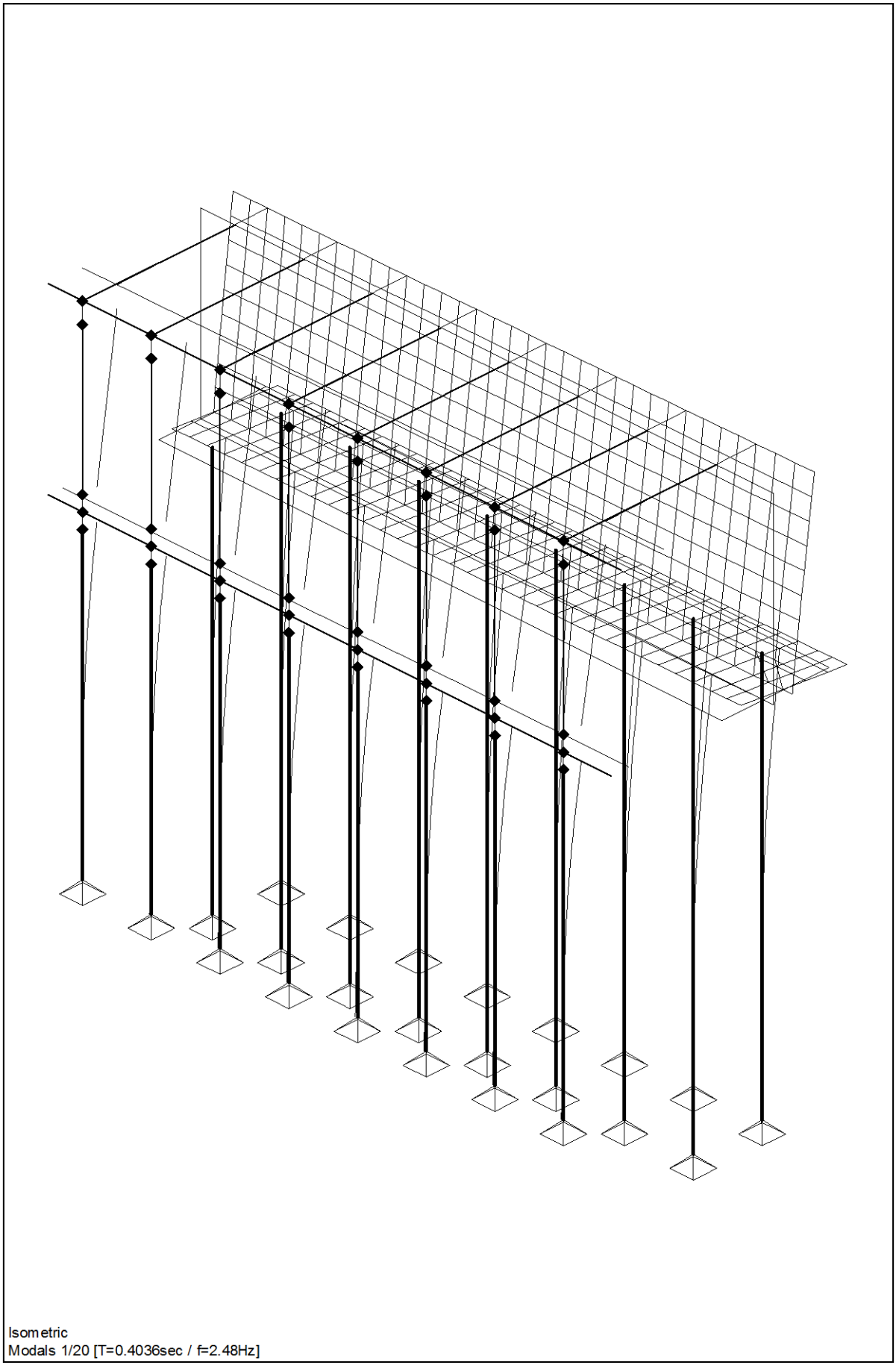
2.5.2. **Излаз** / Exit

Mass distribution per levels

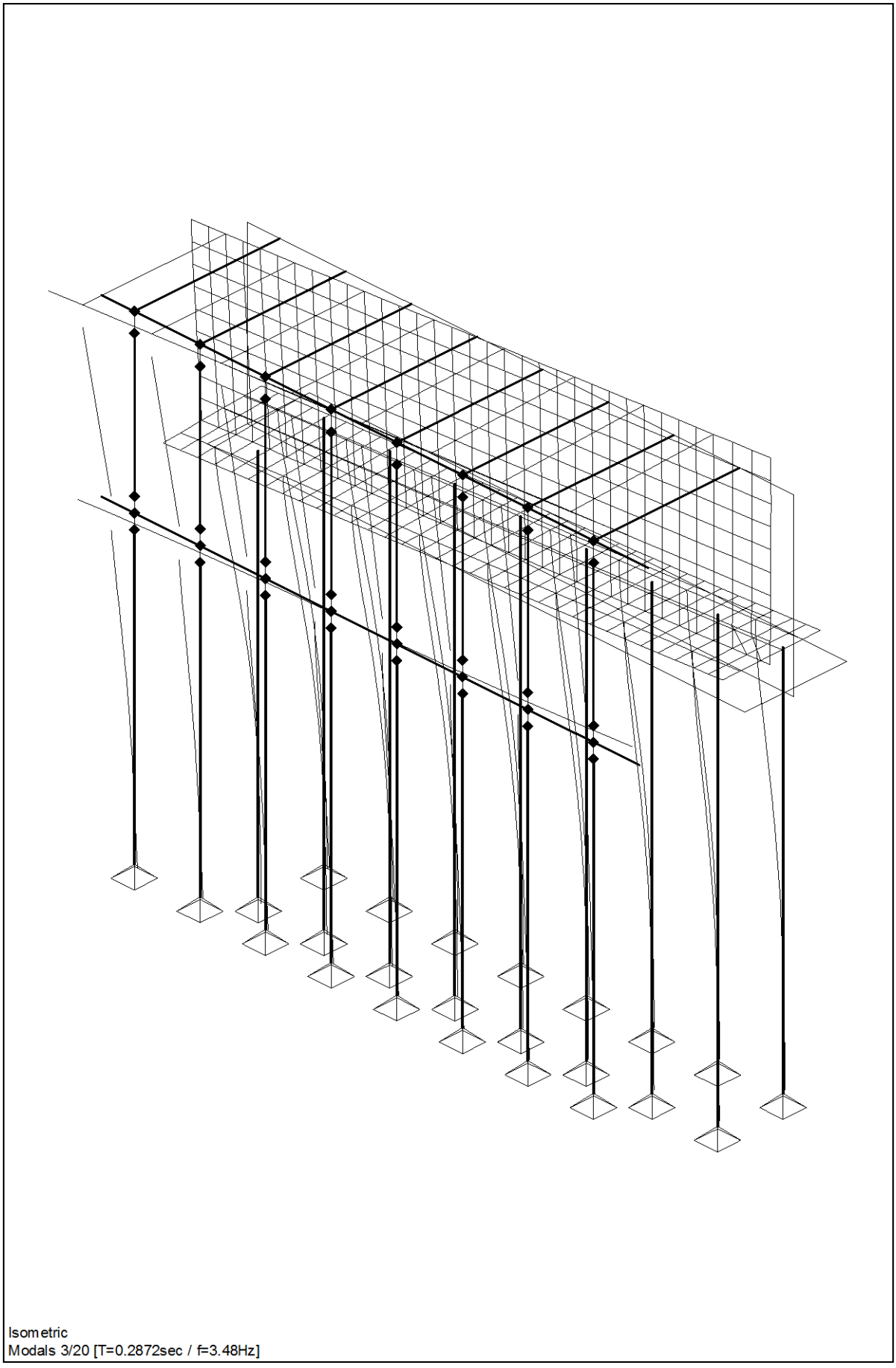
Level	Z [m]	X [m]	Y [m]	Mass [T]	T/m²
	0.00	14.87	9.69	644.68	
	-9.05	14.60	11.24	2486.85	15.05
Total:	-7.19	14.66	10.92	3131.53	

Natural frequency of structure

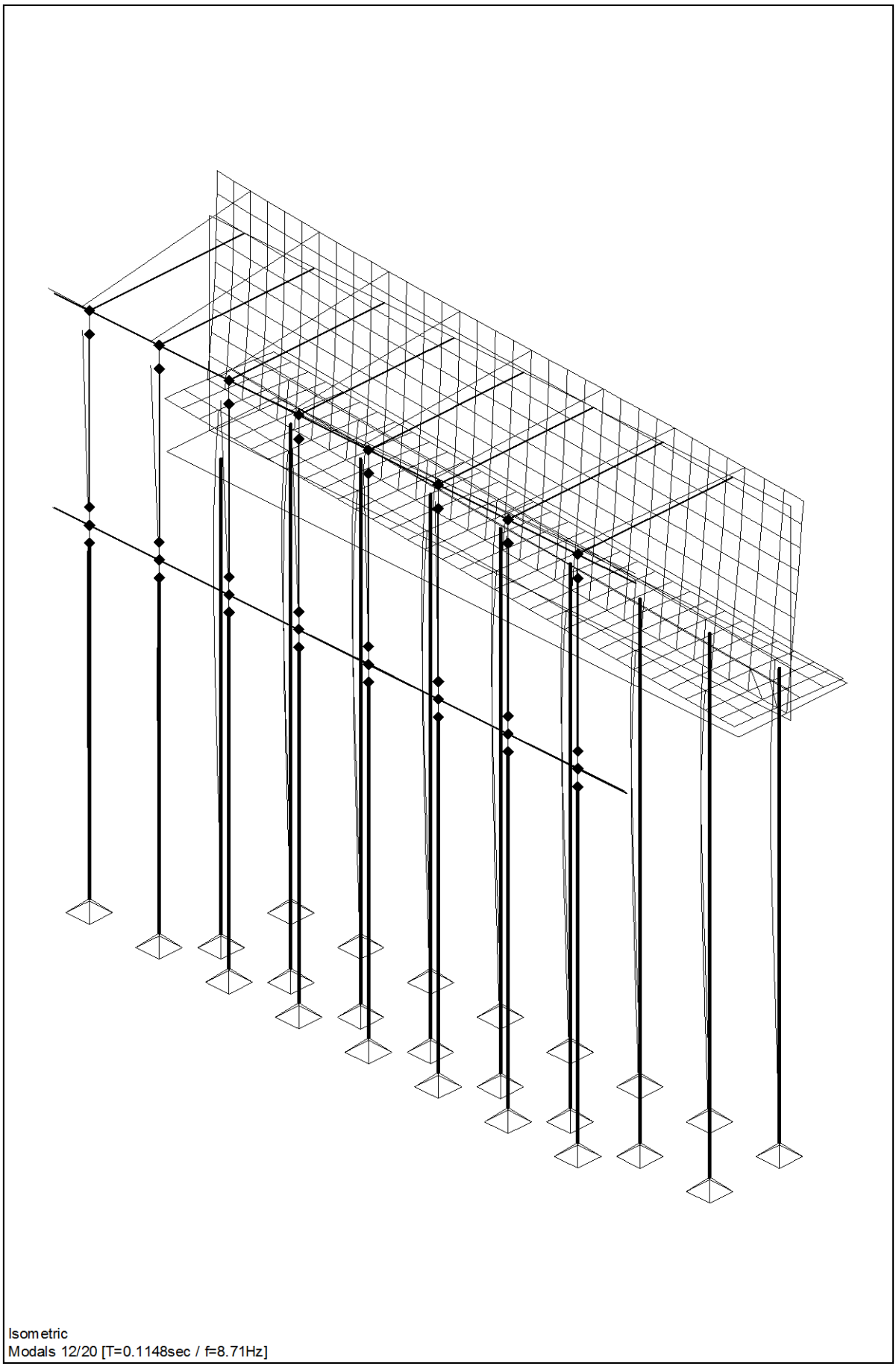
No	T [s]	f [Hz]
1	**0.4036**	**2.4777**
2	0.3330	3.0033
3	**0.2872**	**3.4818**
4	0.1916	5.2192
5	0.1778	5.6252
6	0.1689	5.9221
7	0.1479	6.7607
8	0.1400	7.1432
9	0.1256	7.9614
10	0.1219	8.2002
11	0.1195	8.3652
12	**0.1148**	**8.7133**
13	0.1015	9.8562
14	0.0971	10.3020
15	0.0939	10.6508
16	0.0923	10.8356
17	0.0922	10.8487
18	0.0919	10.8847
19	0.0918	10.8934
20	0.0918	10.8981



Isometric
Modals 1/20 [T=0.4036sec / f=2.48Hz]



Isometric
Modals 3/20 [T=0.2872sec / f=3.48Hz]



Isometric
Modals 12/20 [T=0.1148sec / f=8.71Hz]

Seismic analysis: EC8 (EN 1998)

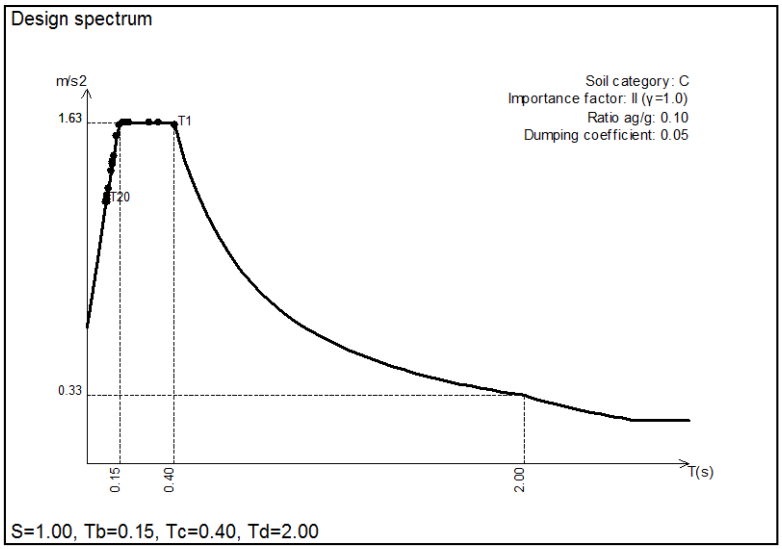
Soil category:	C
Importance factor:	II (γ=1.0)
Ratio ag/g:	0.10
Dumping coefficient:	0.05

Earthquake directional factors:

Load case	Angle α[°]	k,α	k,α+90°	kz	q
Sx	0	1.000	0.000	0.000	1.500
Sy	90	1.000	0.000	0.000	1.500
Sz	0	0.000	0.000	1.000	1.500

Type of spectrum

Load case	S	Tb	Tc	Td	avg/ag
Sx	1.000	0.150	0.400	2.000	1.000
Sy	1.000	0.150	0.400	2.000	1.000
Sz	1.000	0.150	0.400	2.000	1.000



Distribution factors - mass involvement

Mode	U [α=0°]	U [α=90°]	U [α=0°]	U [Z]
1	0.01	59.32	0.01	0.01
2	3.67	0.48	3.67	0.00
3	67.55	0.01	67.55	0.00
4	0.28	0.00	0.28	0.00
5	0.00	0.57	0.00	0.01
6	0.00	0.13	0.00	0.00
7	0.02	16.43	0.02	0.03
8	5.32	0.11	5.32	0.01
9	1.33	0.04	1.33	0.68
10	0.00	0.06	0.00	0.00
11	0.65	0.07	0.65	13.11
12	0.25	0.21	0.25	63.59
13	0.00	0.00	0.00	0.08
14	0.03	0.67	0.03	14.65
15	0.06	1.33	0.06	6.43
16	0.00	2.12	0.00	0.03
17	0.00	10.23	0.00	0.20
18	0.01	0.06	0.01	0.03
19	0.09	0.01	0.09	0.04
20	0.00	0.10	0.00	0.01
ΣU (%)	79.27	91.95	79.27	98.92

3. **Параметри тла /** soil parameters

Table 14. *Overview of adopted soil parameters for model 1 (Frames 1, 2.1 and 3.1)*

Layer designation	z (m)	d (m)	γ (kN/m³)	φ (°)	c (kN/m²)	M_v (kN/m²)	ν	E_s (MN/m²)	E_p (MN/m²)	K_h (MN/m³) *Mayerhof & Baike*	K_h (MN/m³) *Vesić*
siSa	5.5	5.5	20.3	26	12	13600	0.30	10.10	30000	9.25	3.97
	7.8	2.3	10			11400		8.47		7.75	3.28
SaP	28.4	20.6	10	30	5	15000	0.28	11.73		10.61	4.61
						27000		21.12		19.10	8.71
						18000		14.08		12.73	5.62

Table 15. *Overview of adopted soil parameters for model 2 (Frames 2.2, 3.2 and 4)*

Layer designation	z (m)	d (m)	γ (kN/m³)	φ (°)	c (kN/m²)	M_v (kN/m²)	ν	E_s (MN/m²)	E_p (MN/m²)	K_h (MN/m³) *Mayerhof & Baike*	K_h (MN/m³) *Vesić*
siSa	5.5	5.5	20.3	26	12	13600	0.30	10.10	30000	9.25	3.97
	8.2	2.7	10			11400		8.47		7.75	3.28
SaP	24.6	16.4	10	30	5	15000	0.28	11.73		10.61	4.61
						27000		21.12		19.10	8.71
						18000		14.08		12.73	5.62

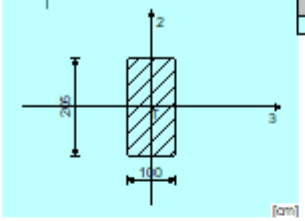
Table 16. *Overview of adopted soil parameters for model 3 (Frame 5)*

Layer designation	z (m)	d (m)	γ (kN/m³)	φ (°)	c (kN/m²)	M_v (kN/m²)	ν	E_s (MN/m²)	E_p (MN/m²)	K_h (MN/m³) *Mayerhof & Baike*	K_h (MN/m³) *Vesić*
siSa	5.5	5.5	20.3	26	12	13600	0.30	10.10	30000	9.25	3.97
	8.3	2.8	10			11400		8.47		7.75	3.28
SaP	22.1	13.8	10	30	5	15000	0.28	11.73		10.61	4.61
						27000		21.12		19.10	8.71
						18000		14.08		12.73	5.62

4. **Статички модел /** Static model

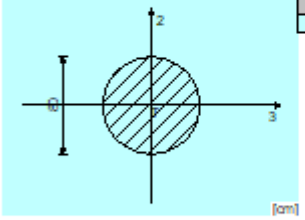
Set: 1 Section: b/d=100/205, Approx. eccentricity

Mat.	A1	A2	A3	I1	I2	I3
2 - C 30/37	2.050e+0	1.708e+0	1.708e+0	4.743e-1	1.708e-1	7.179e-1



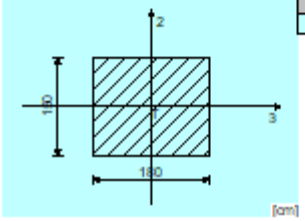
Set: 2 Section: D=80, Approx. eccentricity

Mat.	A1	A2	A3	I1	I2	I3
3 - C 40/50	5.027e-1	4.524e-1	4.524e-1	4.021e-2	2.011e-2	2.011e-2



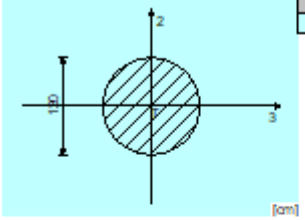
Set: 3 Section: b/d=180/150, Approx. eccentricity

Mat.	A1	A2	A3	I1	I2	I3
2 - C 30/37	2.700e+0	2.250e+0	2.250e+0	1.005e+0	7.290e-1	5.063e-1



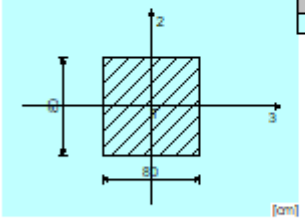
Set: 4 Section: D=120, Approx. eccentricity

Mat.	A1	A2	A3	I1	I2	I3
2 - C 30/37	1.131e+0	1.018e+0	1.018e+0	2.036e-1	1.018e-1	1.018e-1



Set: 5 Section: b/d=80/80, Approx. eccentricity

Mat.	A1	A2	A3	I1	I2	I3
2 - C 30/37	6.400e-1	5.333e-1	5.333e-1	5.769e-2	3.413e-2	3.413e-2

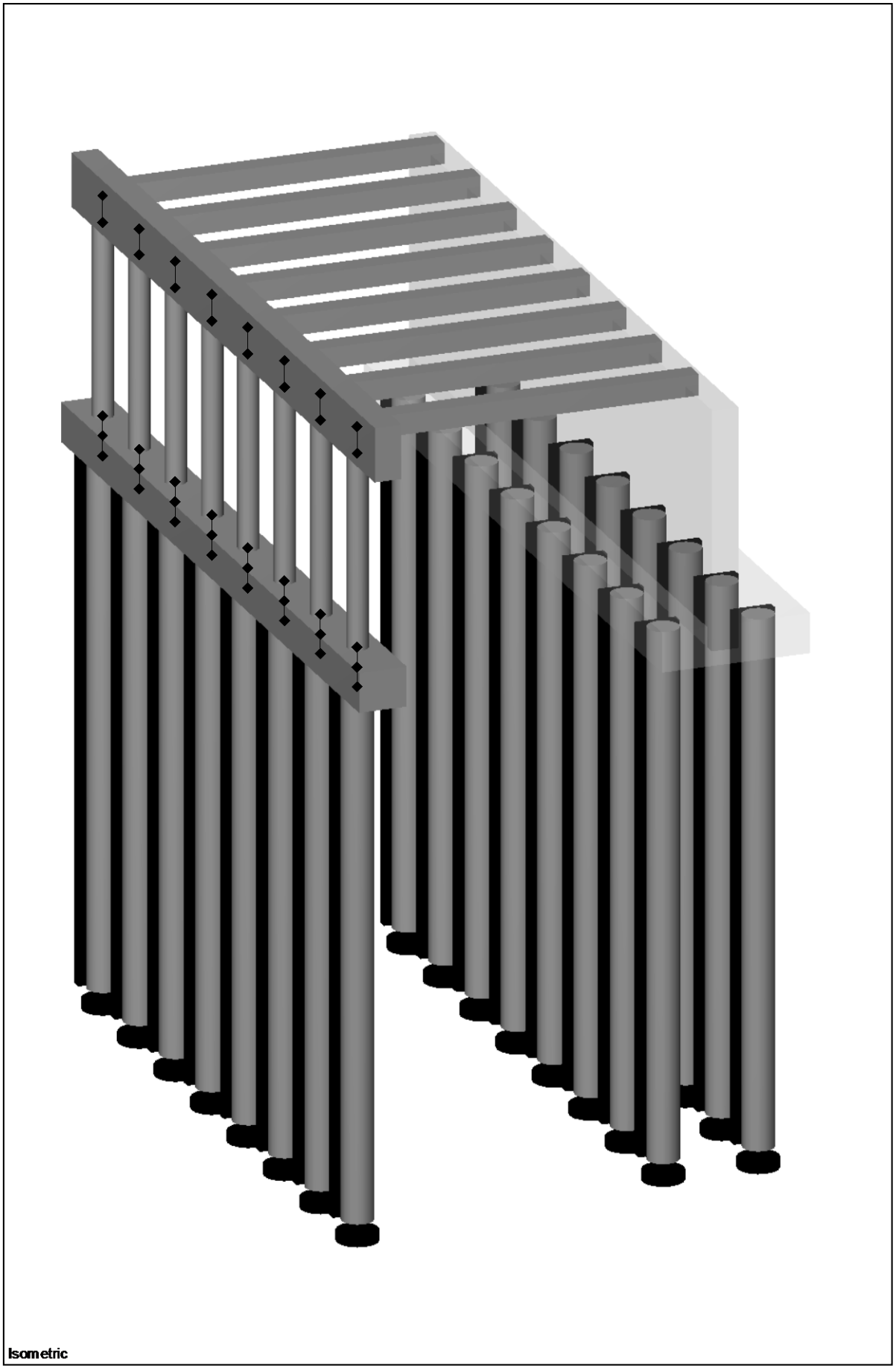


Linear support sets

Set	K,R1	K,R2	K,R3	K,M1	Soil [m]
1		7.750e+3	7.750e+3		
2		1.060e+4	1.060e+4		

Point support sets

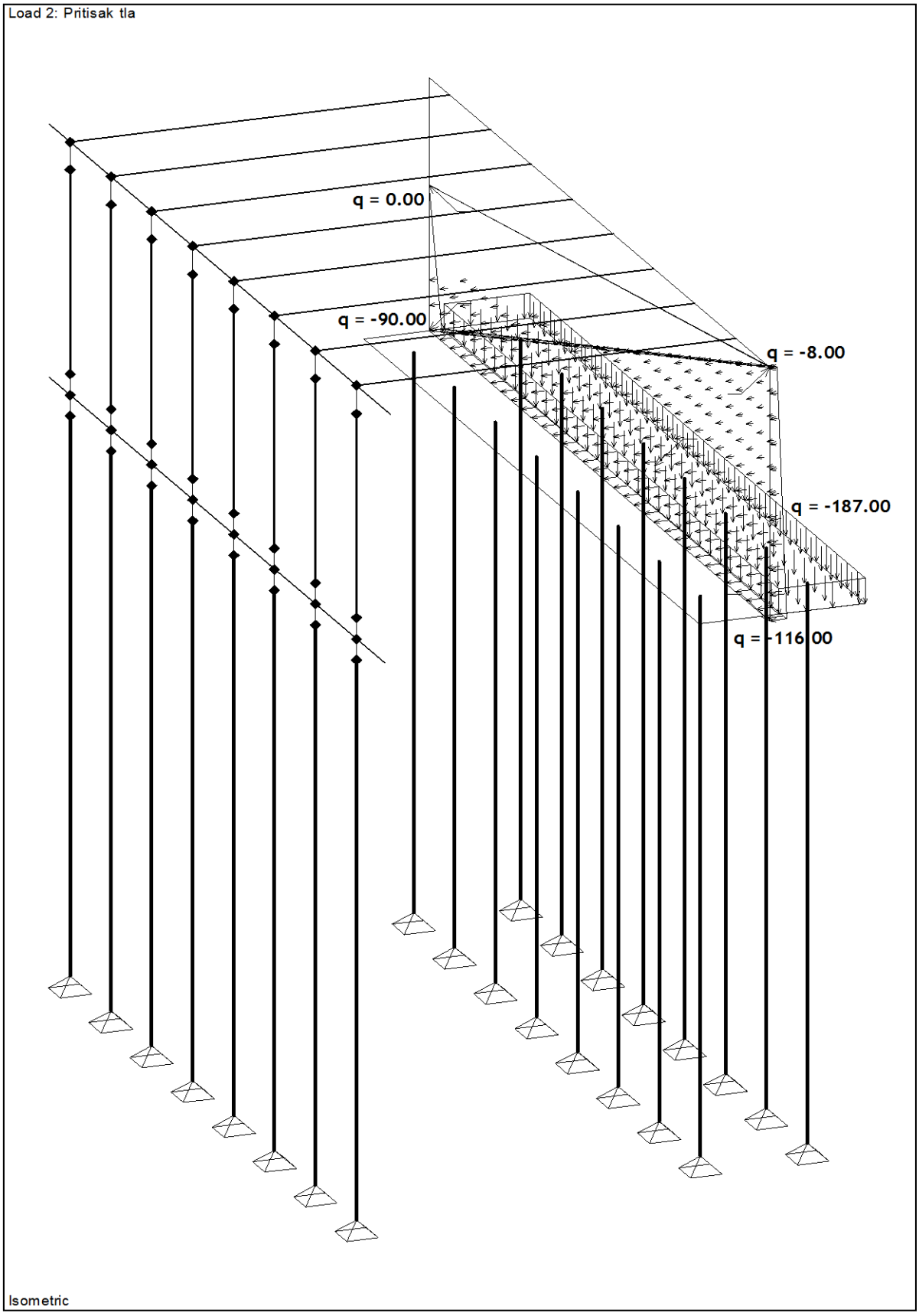
Set	K,R1	K,R2	K,R3	K,M1	K,M2	K,M3
1	2.500e+4	2.500e+4	5.000e+5			


Isometric

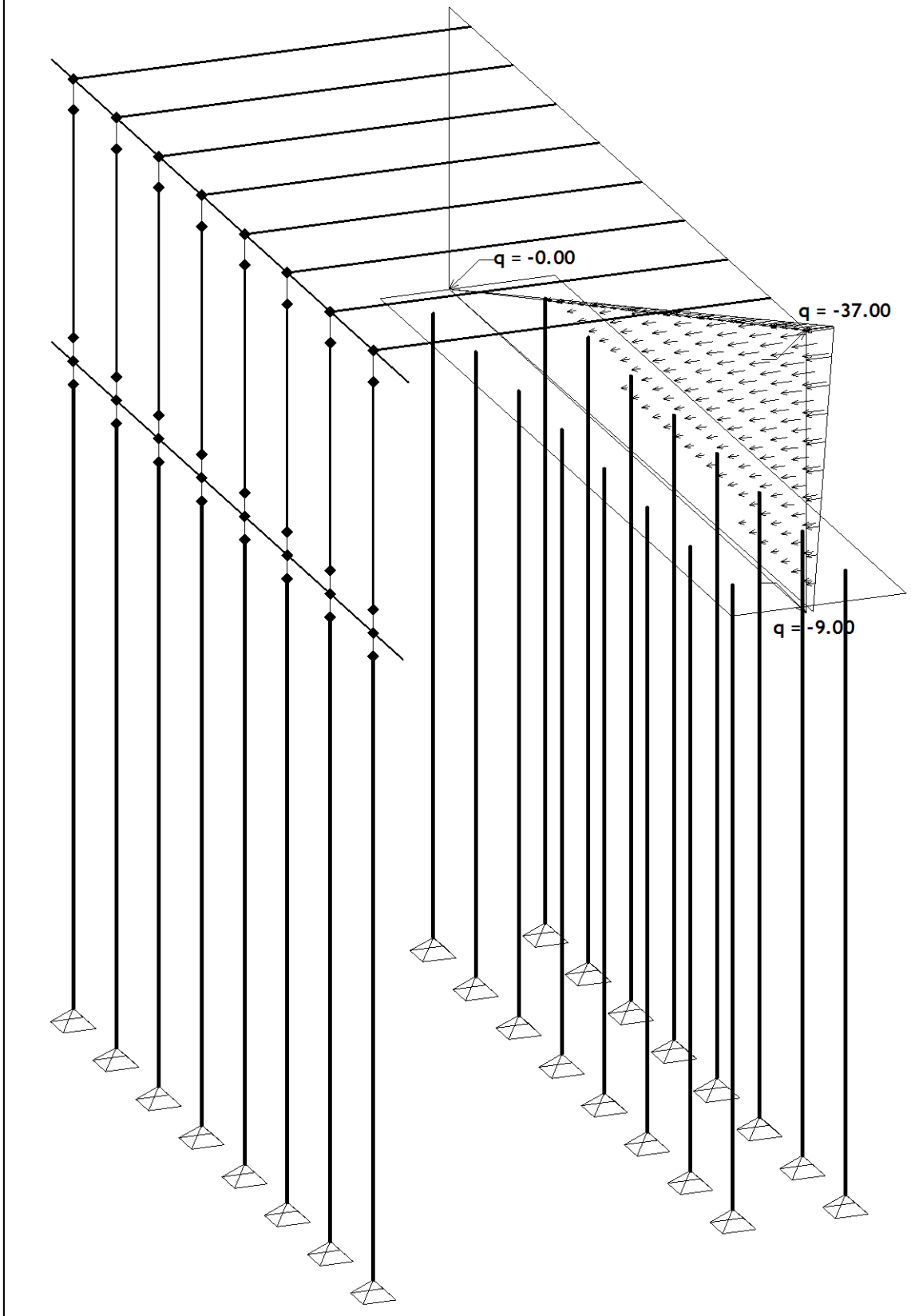
Isometric

5. **Оптерећења /** Loads

5.1. **Улаз** / Entrance

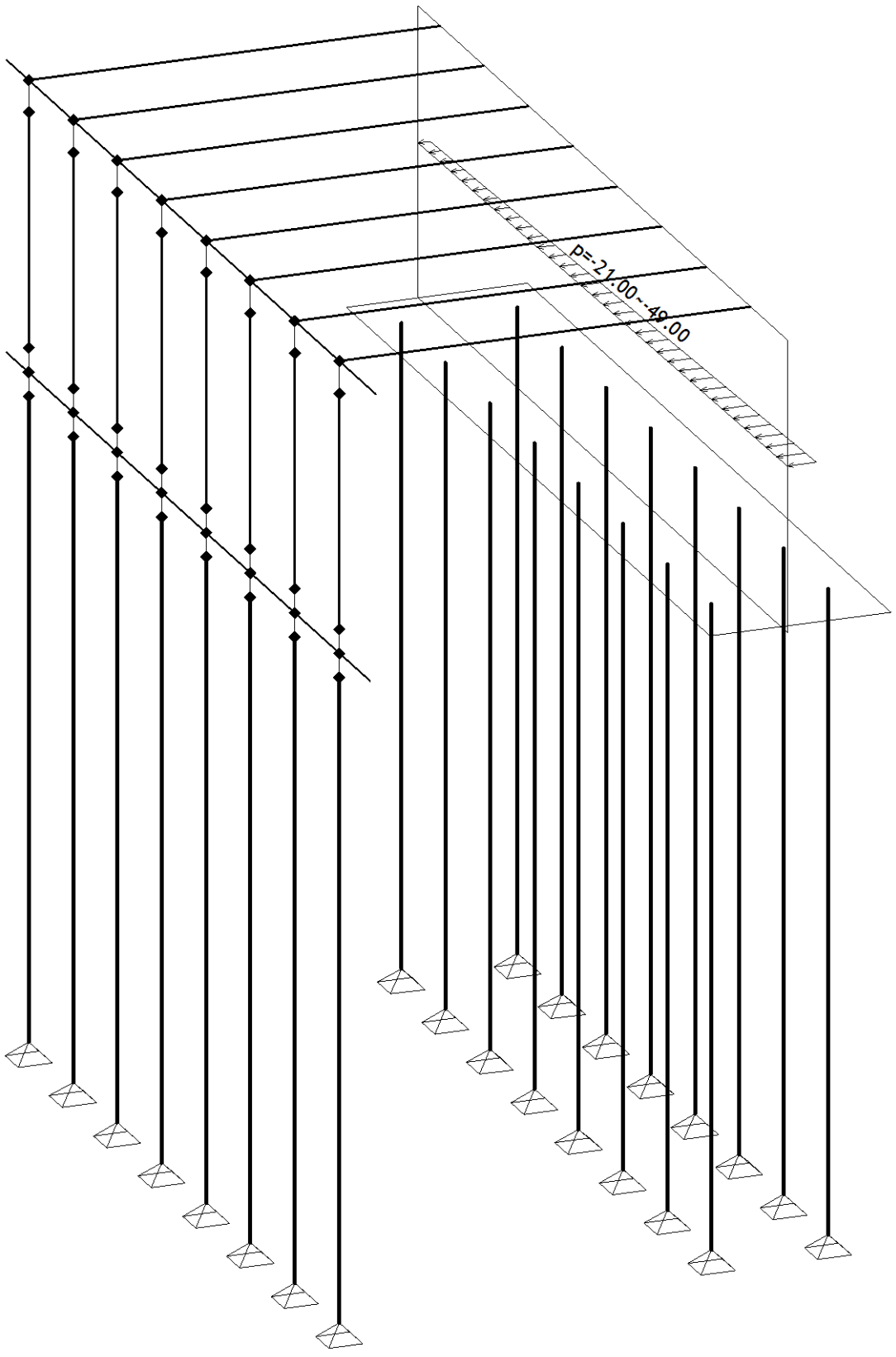


Load 3: Voz na nasipu



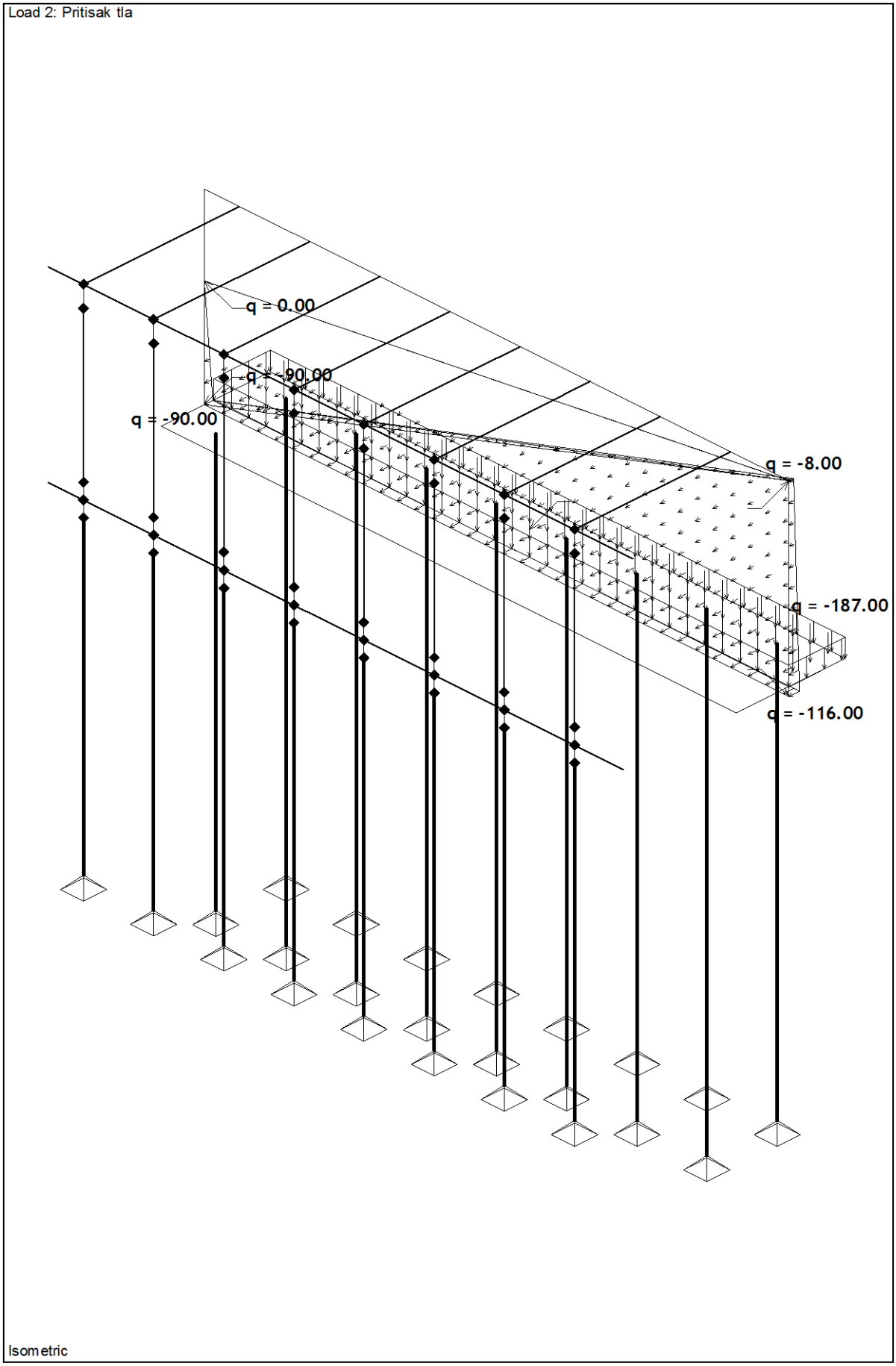
Isometric

Load 4: Seizmicki pritisak tla

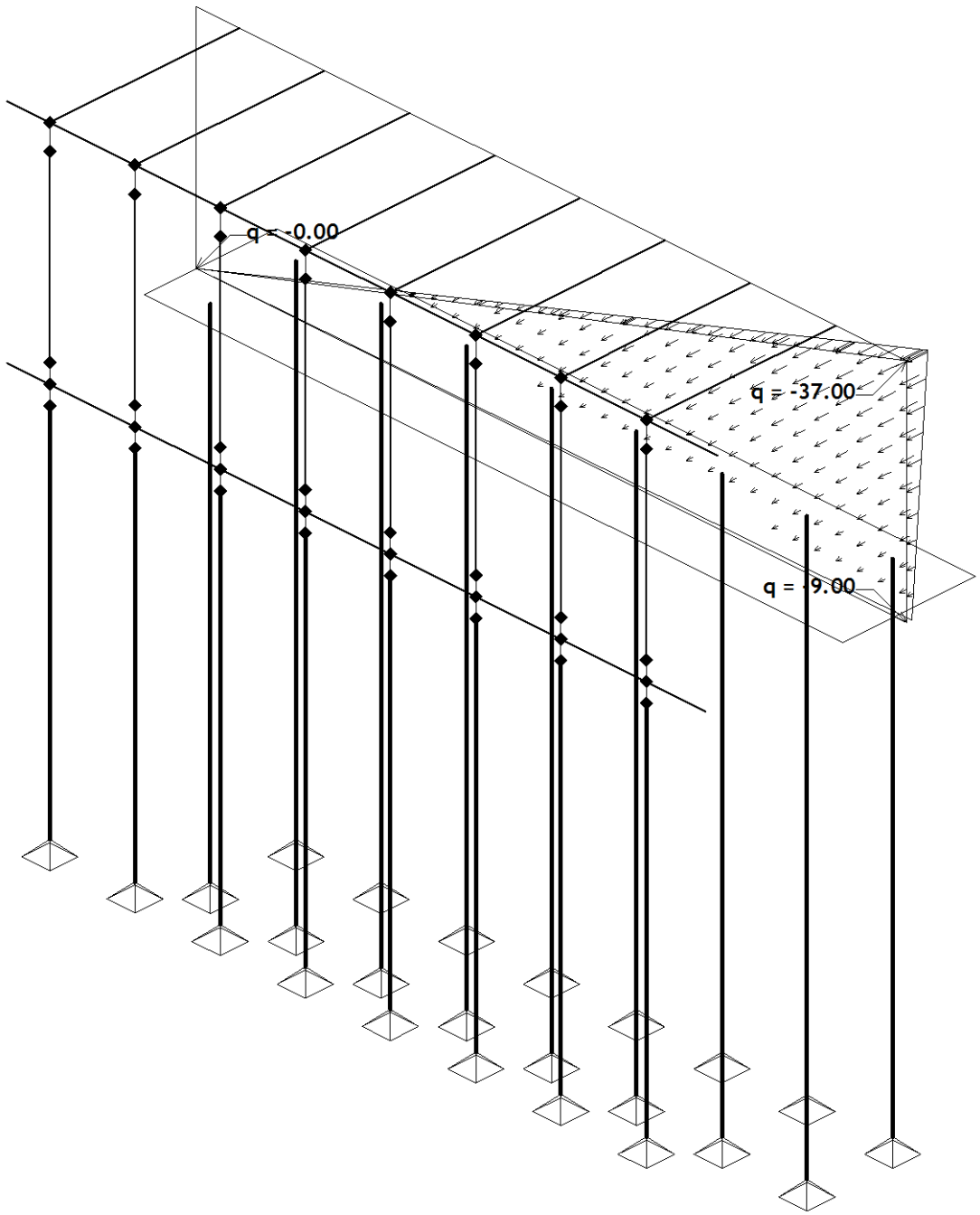


Isometric

5.2. Излаз / Exit

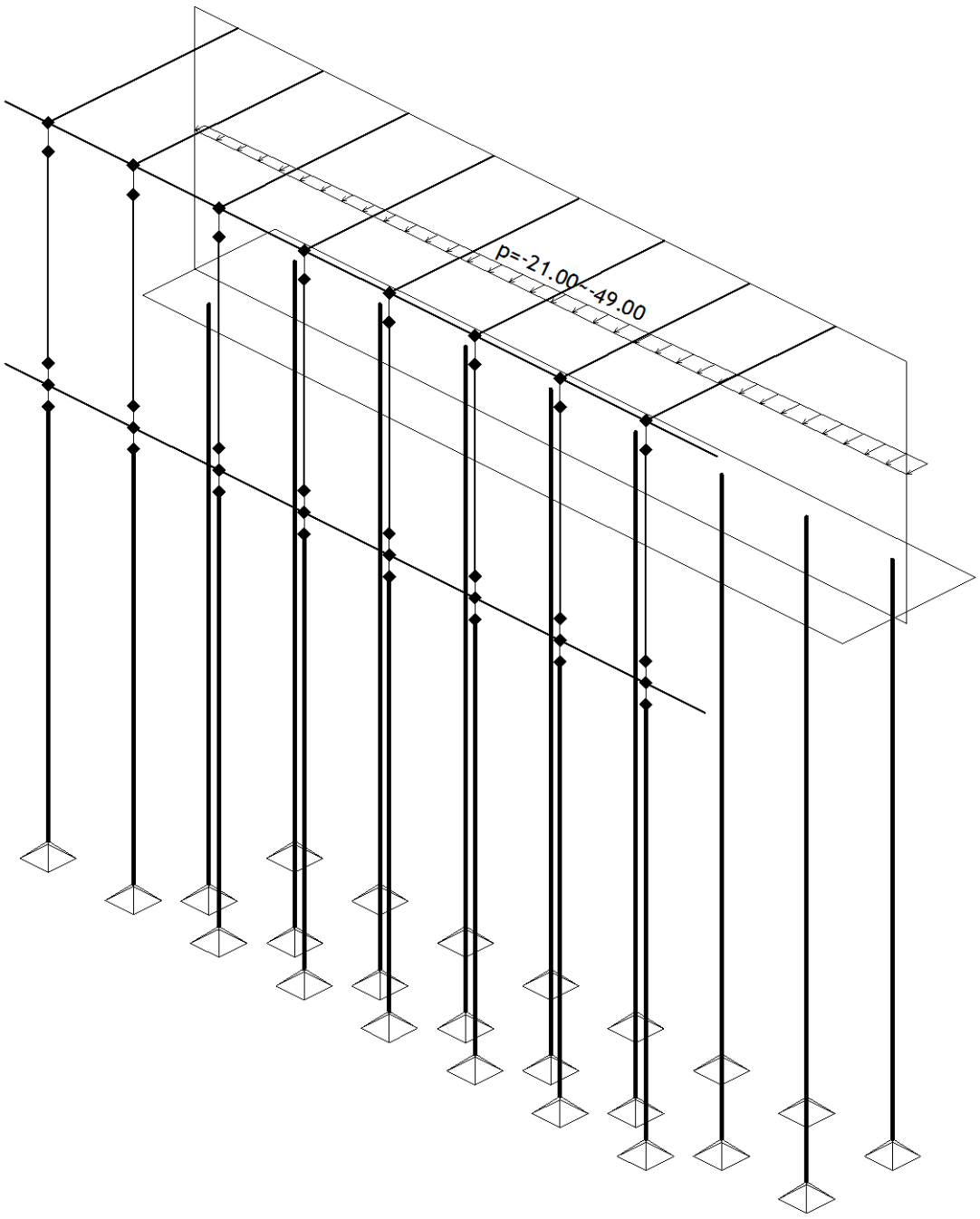


Load 3: Voz na nasipu



Isometric

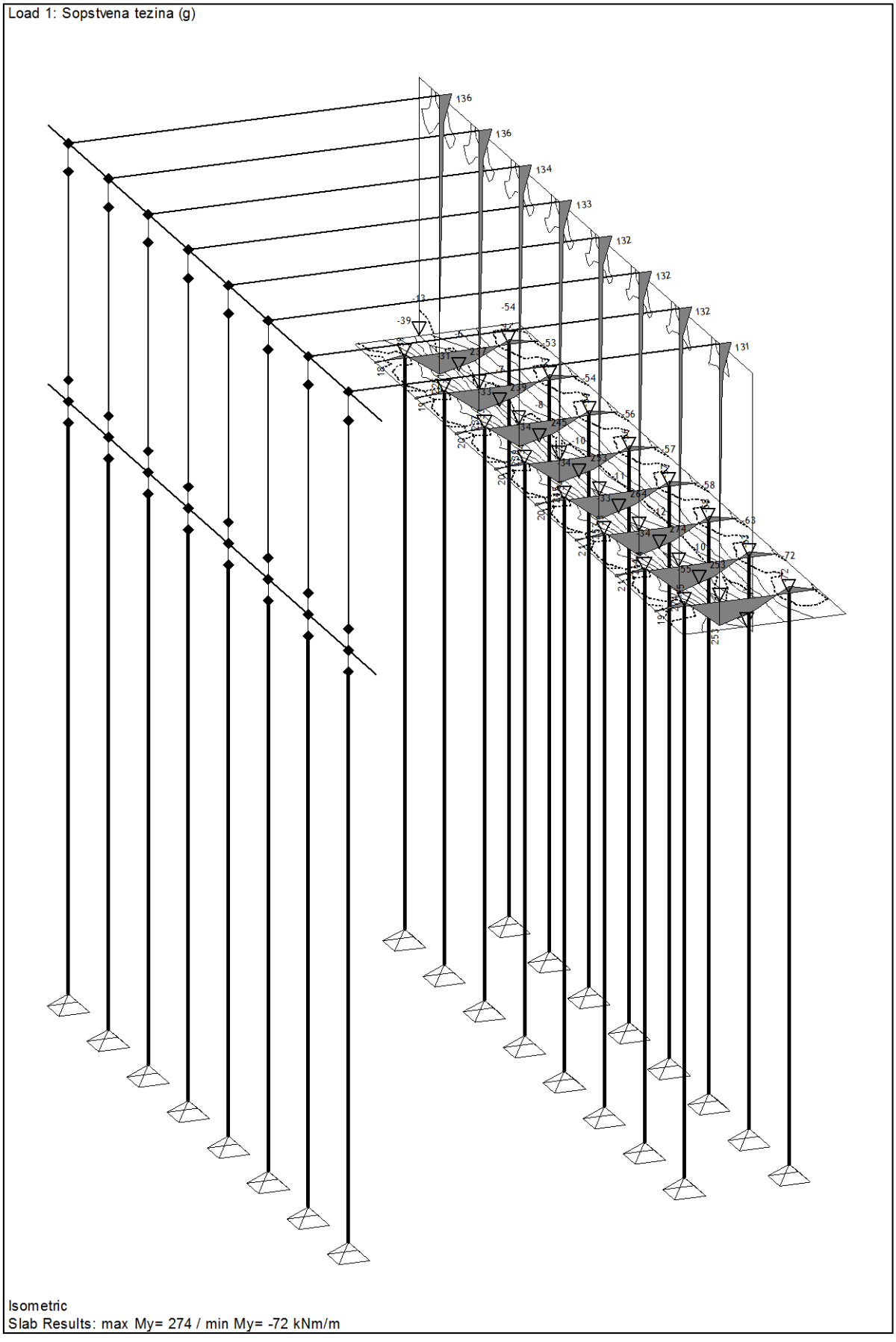
Load 4: Seizmicki pritisak tla



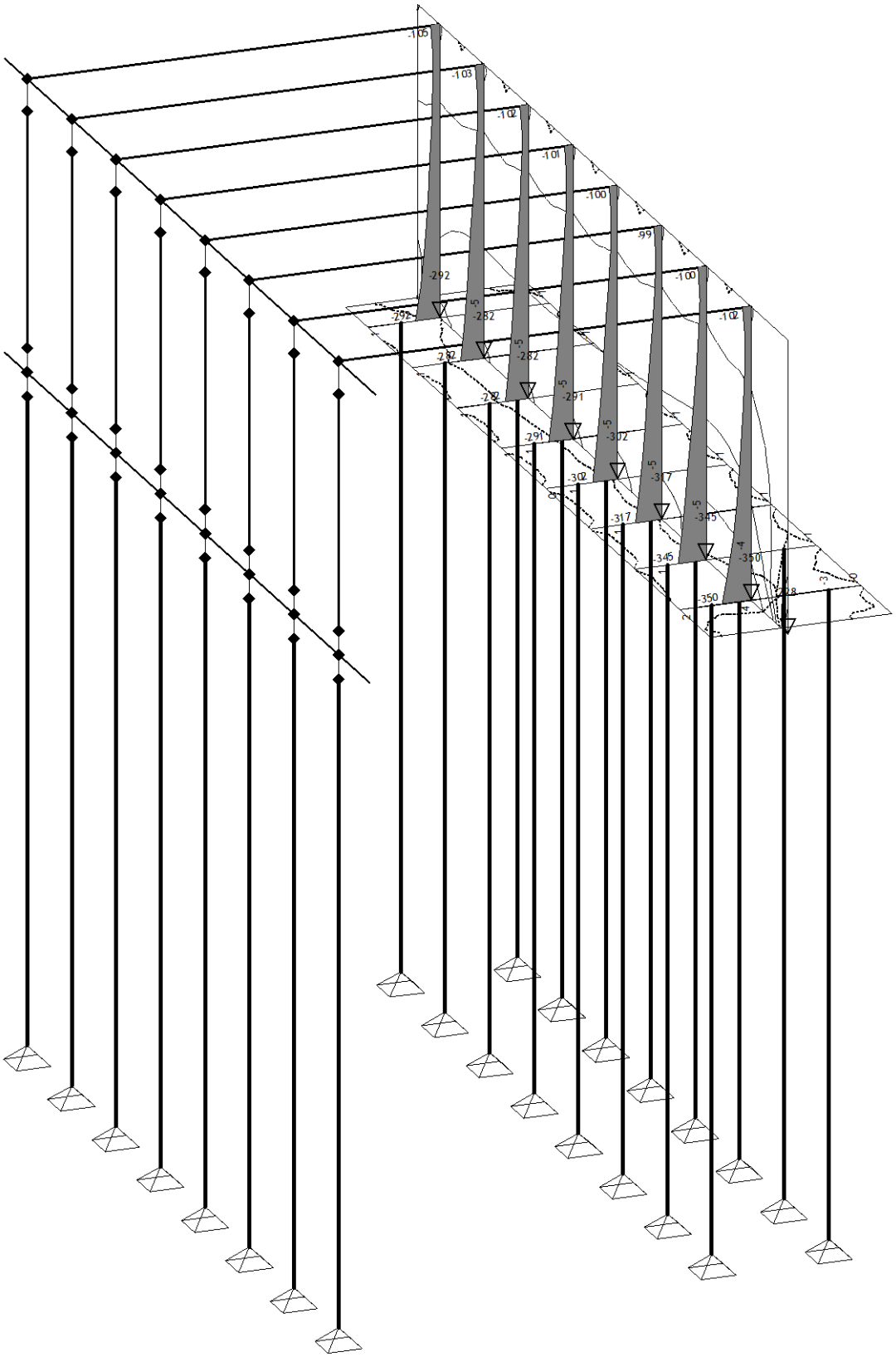
Isometric

6. **Пресечне силе и деформације** / Internal forces and deformations

6.1. **Улаз** / Entrance

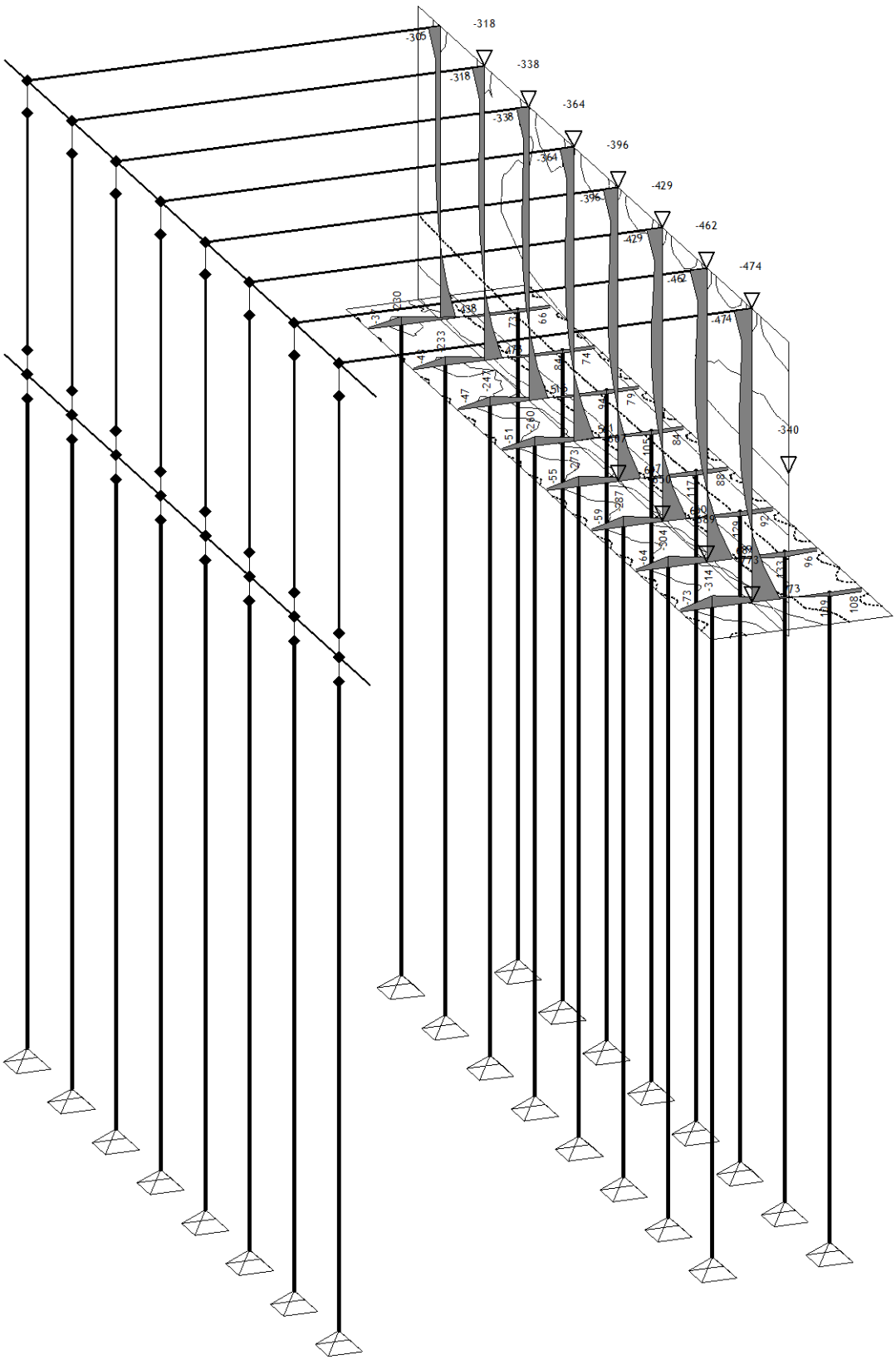


Load 1: Sopstvena tezina (g)



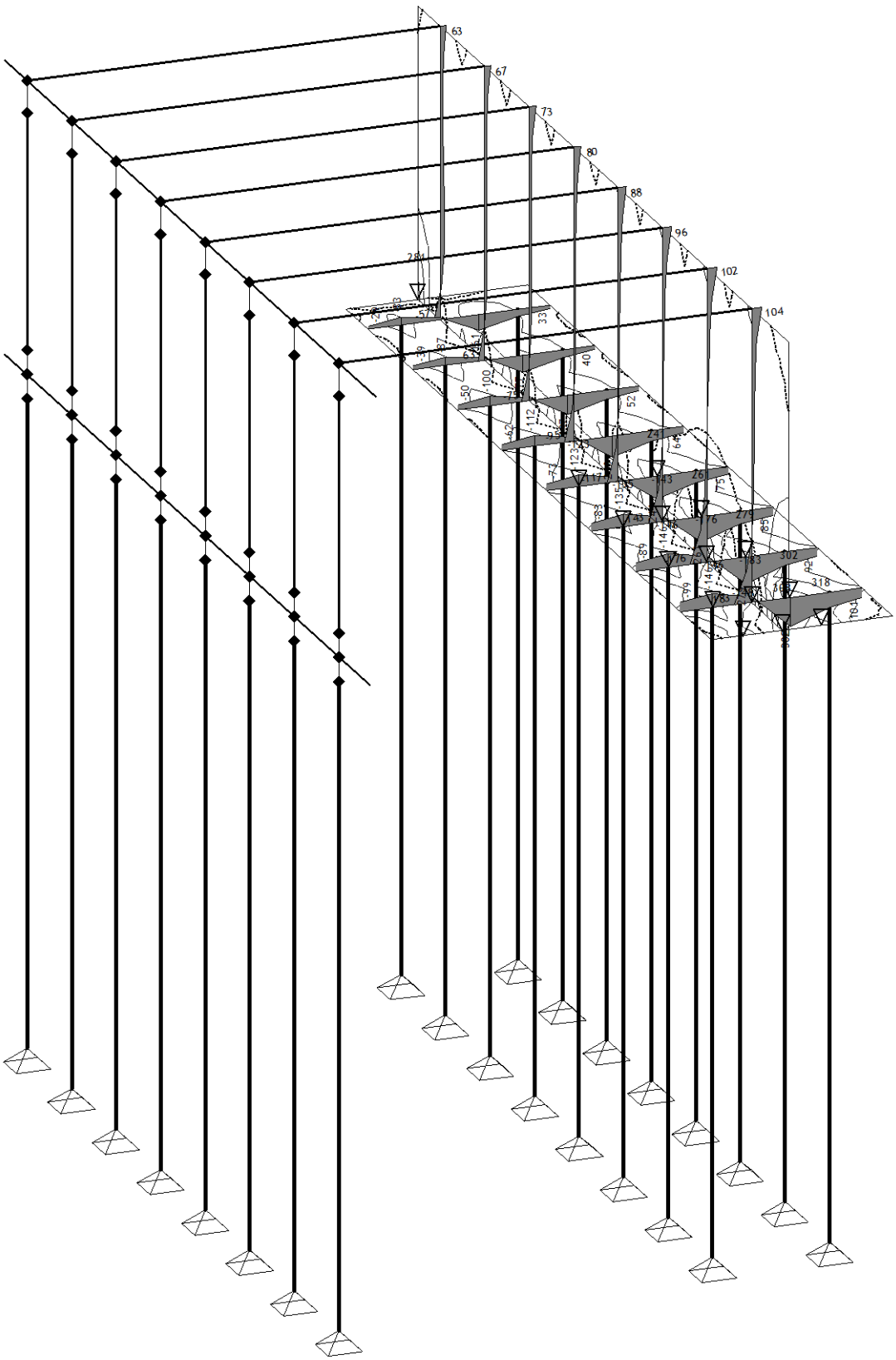
Isometric
Slab Results: max Ny= 228 / min Ny= -350 kN/m

Load 2: Pritisak tla



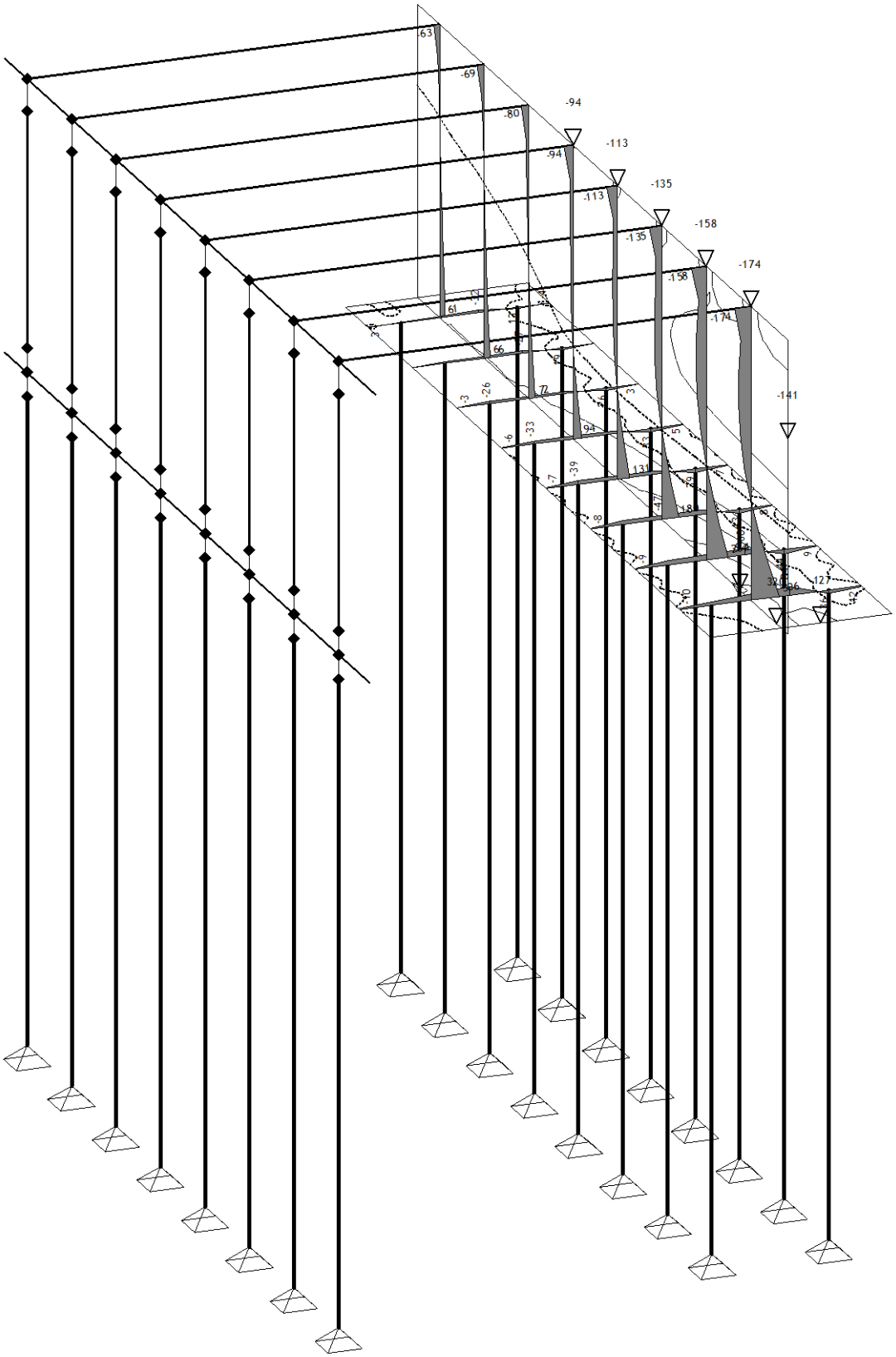
Isometric
Slab Results: max My= 773 / min My= -474 kNm/m

Load 2: Pritisak tla



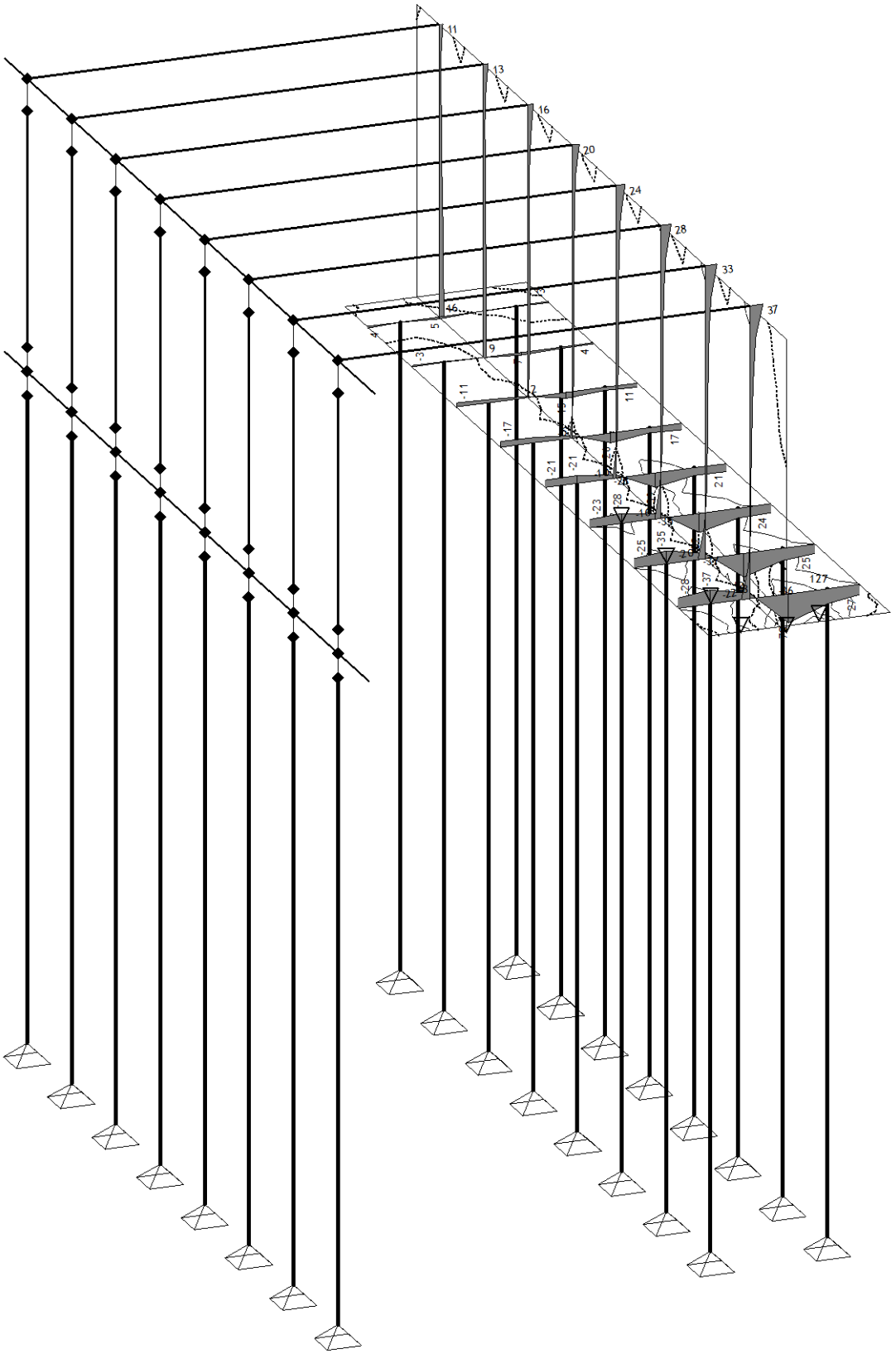
Isometric
Slab Results: max Ny= 318 / min Ny= -183 kN/m

Load 3: Voz na nasipu



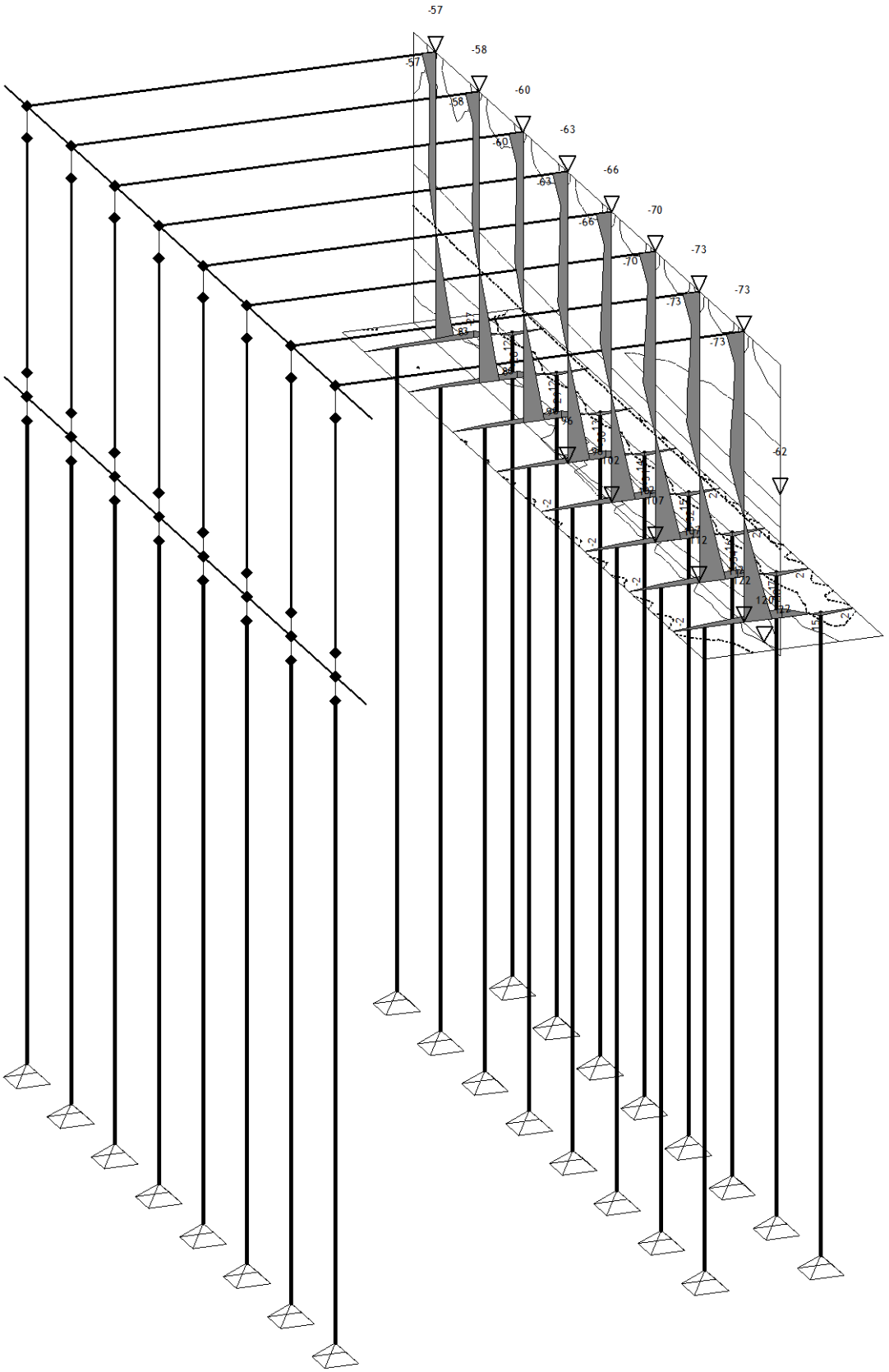
Isometric
Slab Results: max My= 320 / min My= -174 kNm/m

Load 3: Voz na nasipu



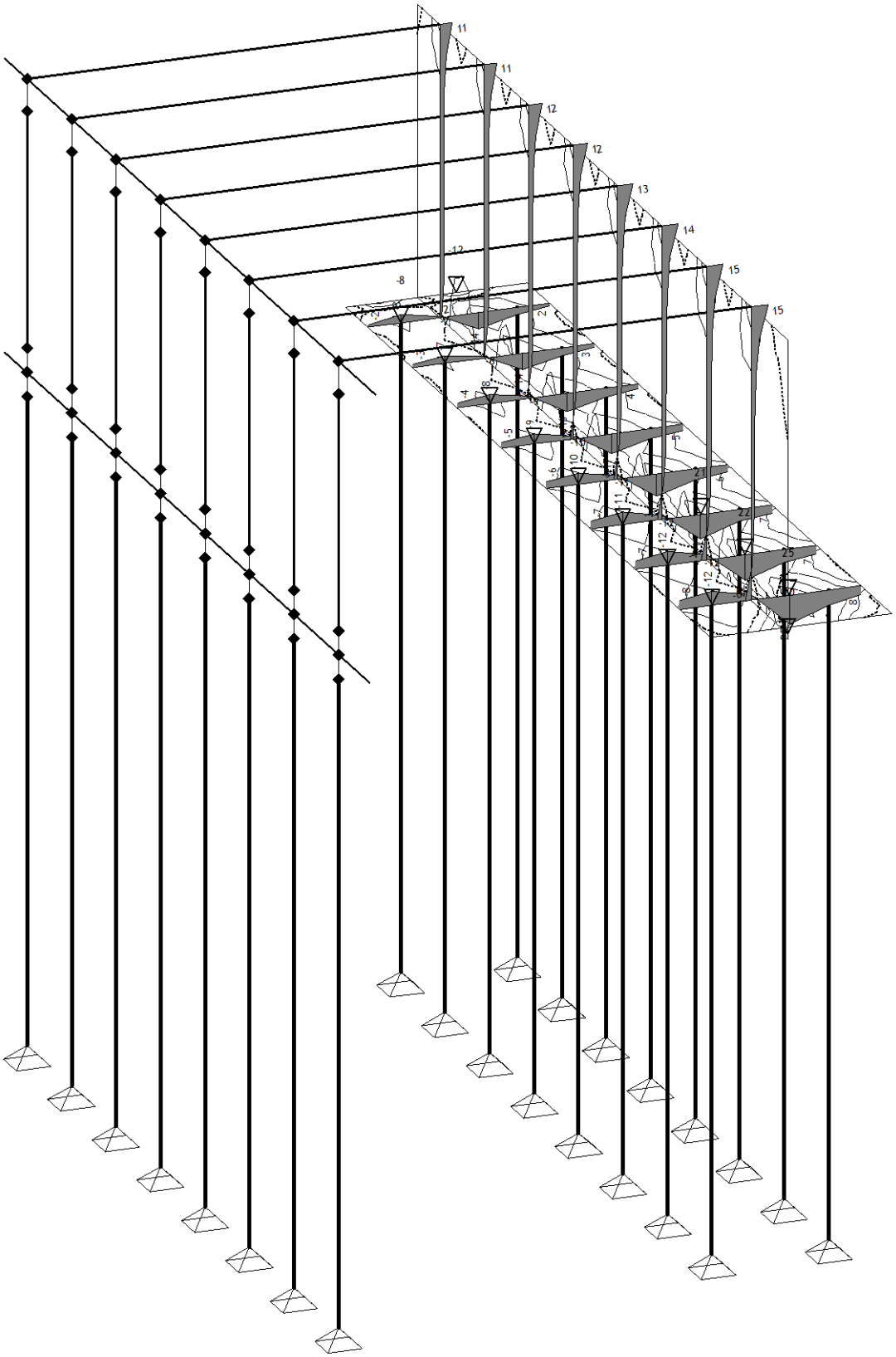
Isometric
Slab Results: max Ny= 127 / min Ny= -48 kN/m

Load 4: Seizmicki pritisak tla



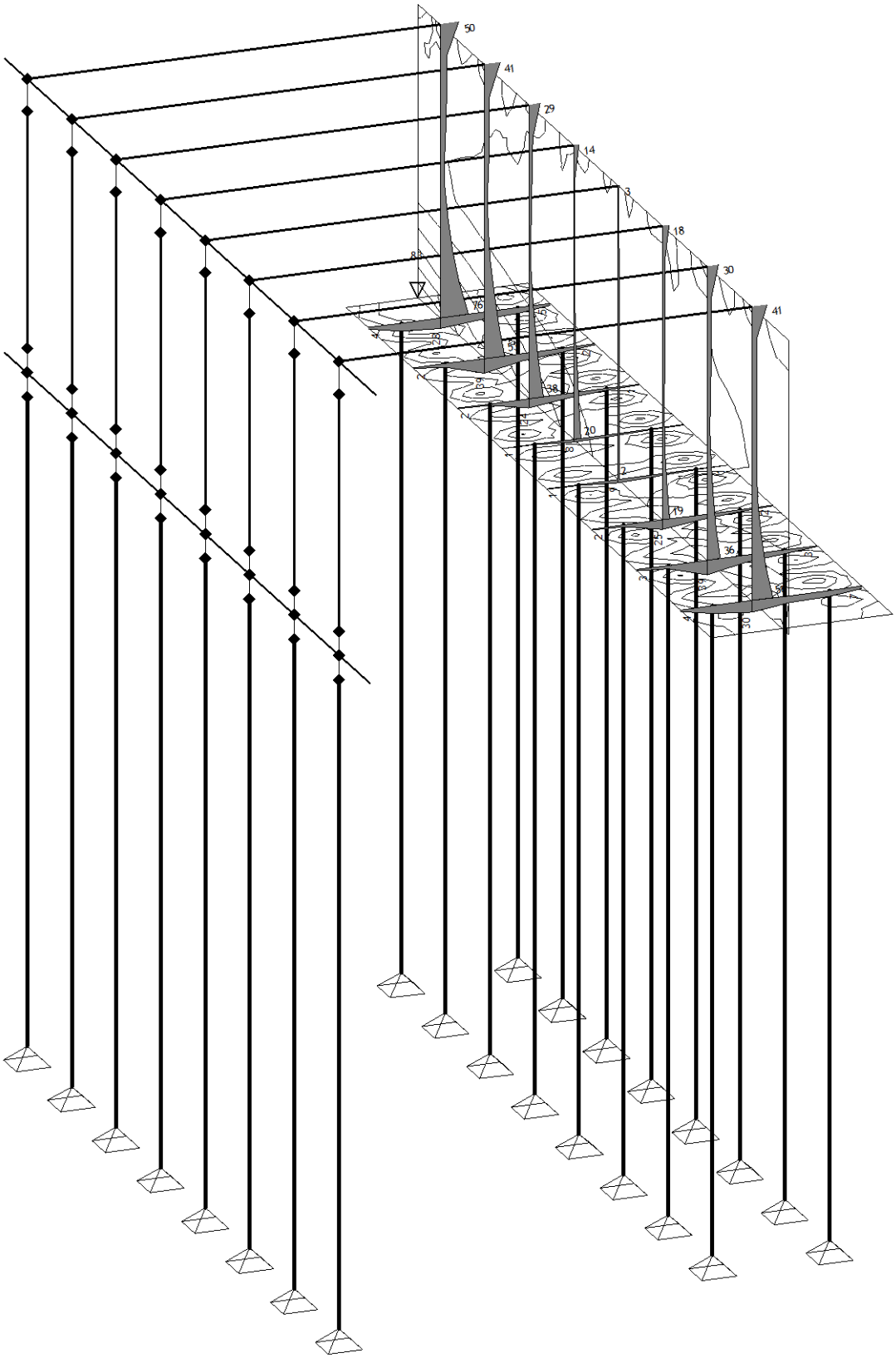
Isometric
Slab Results: max My= 122 / min My= -73 kNm/m

Load 4: Seizmicki pritisak tla



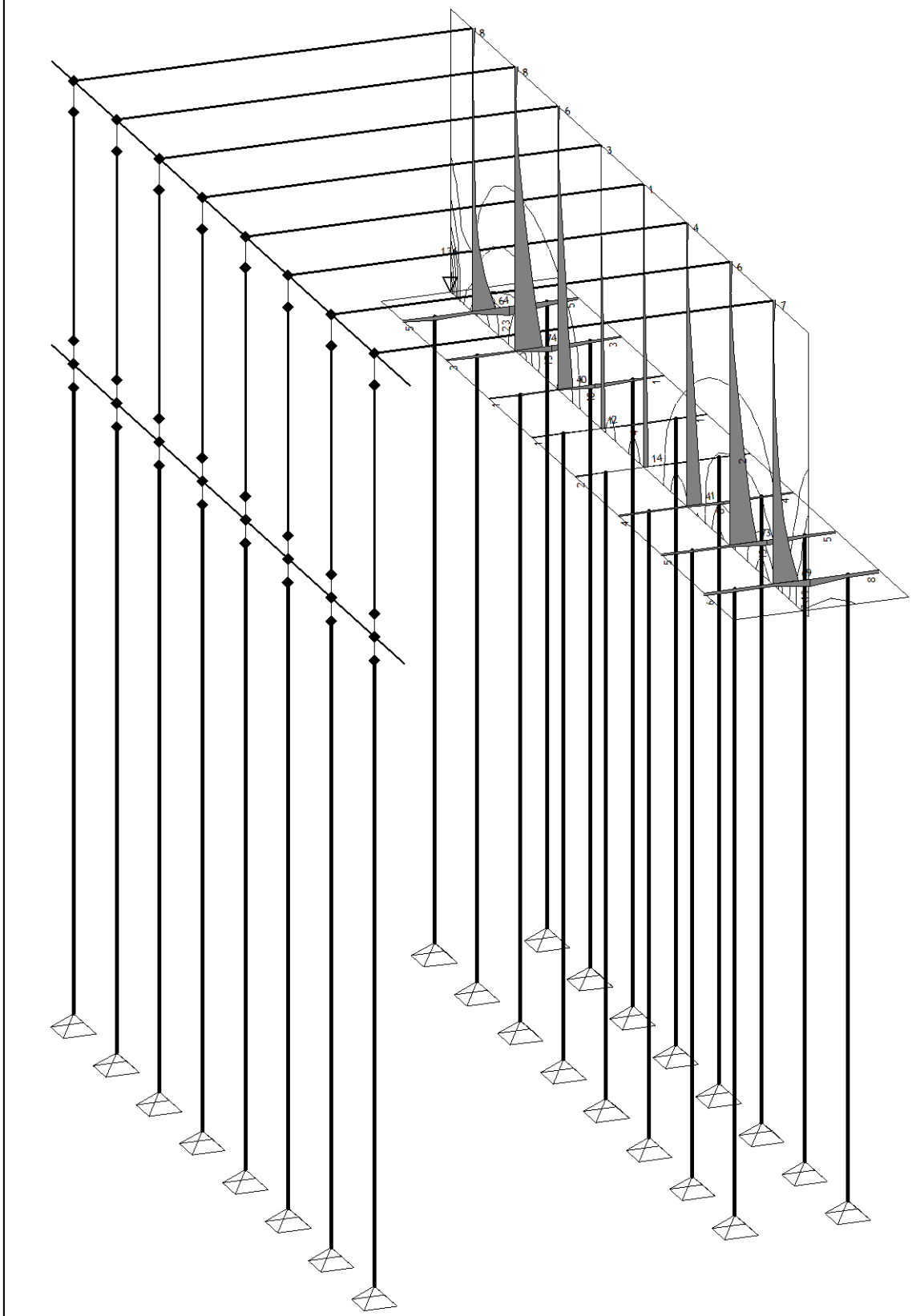
Isometric
Slab Results: max Ny= 25 / min Ny= -12 kN/m

Load 5: Sx



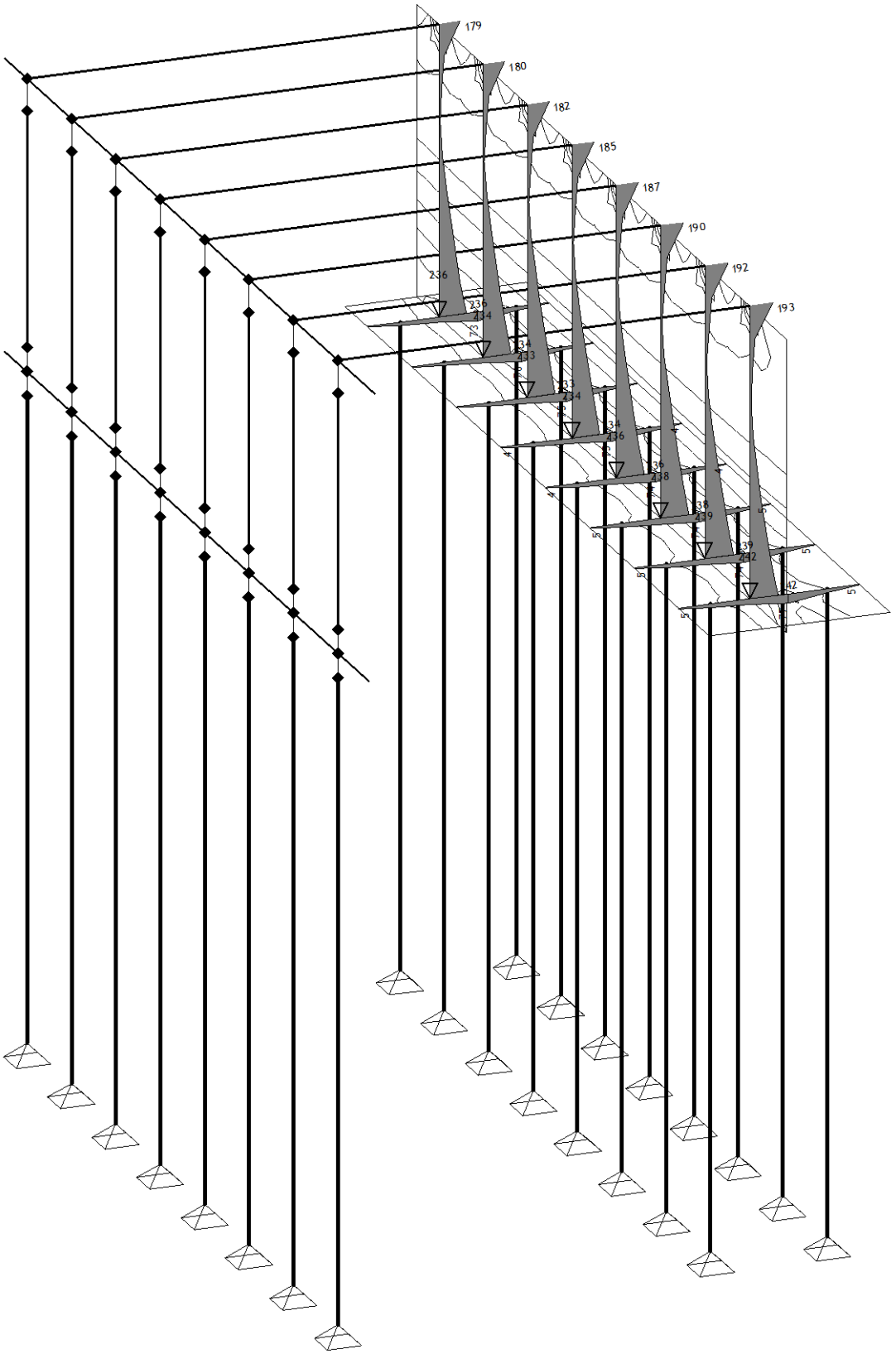
Isometric
Slab Results: max My= 83 / min My= 0 kNm/m

Load 5: Sx



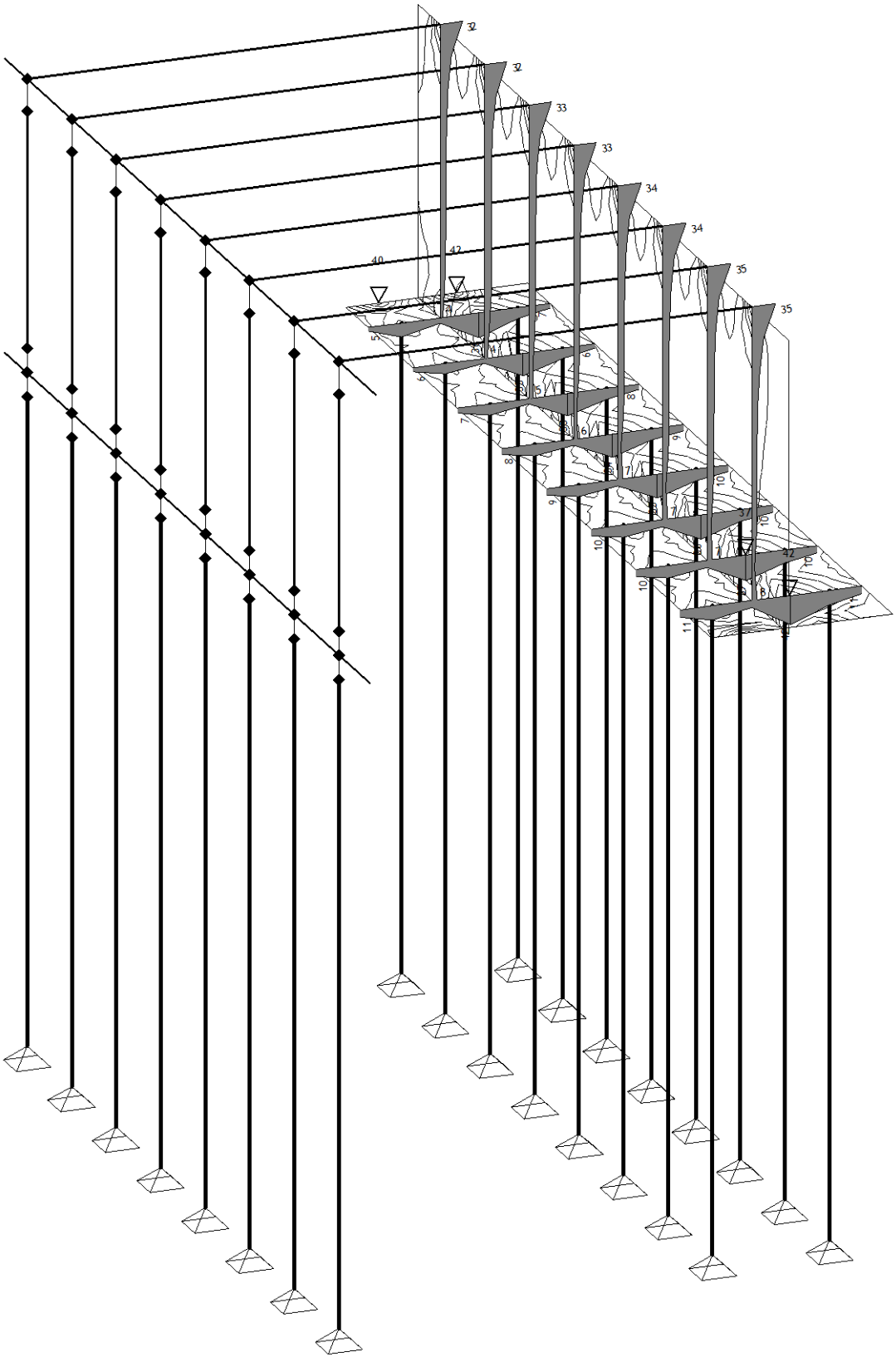
Isometric
Slab Results: max Ny= 136 / min Ny= 0 kN/m

Load 6: Sy



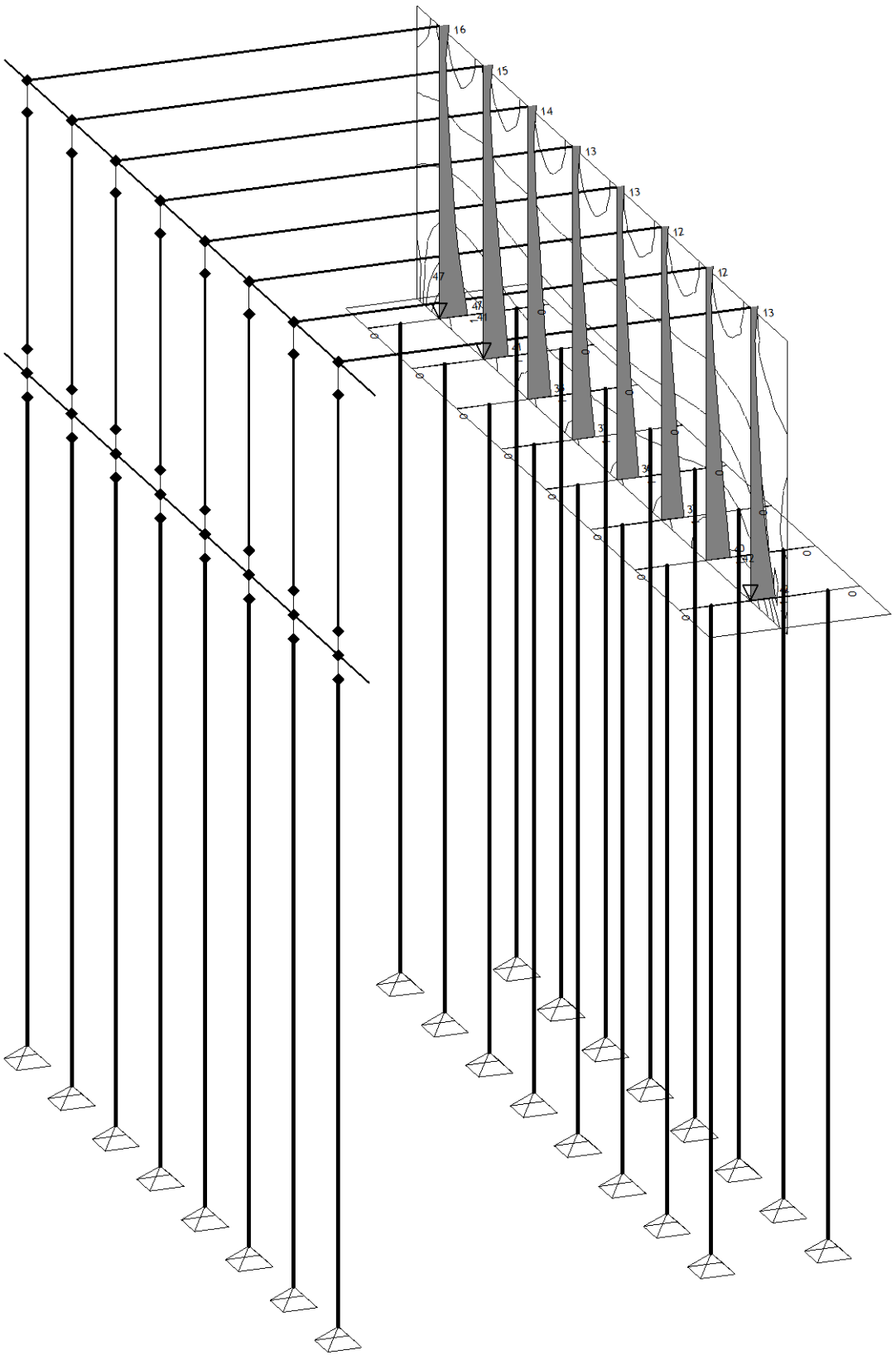
Isometric
Slab Results: max My= 242 / min My= 2 kNm/m

Load 6: Sy



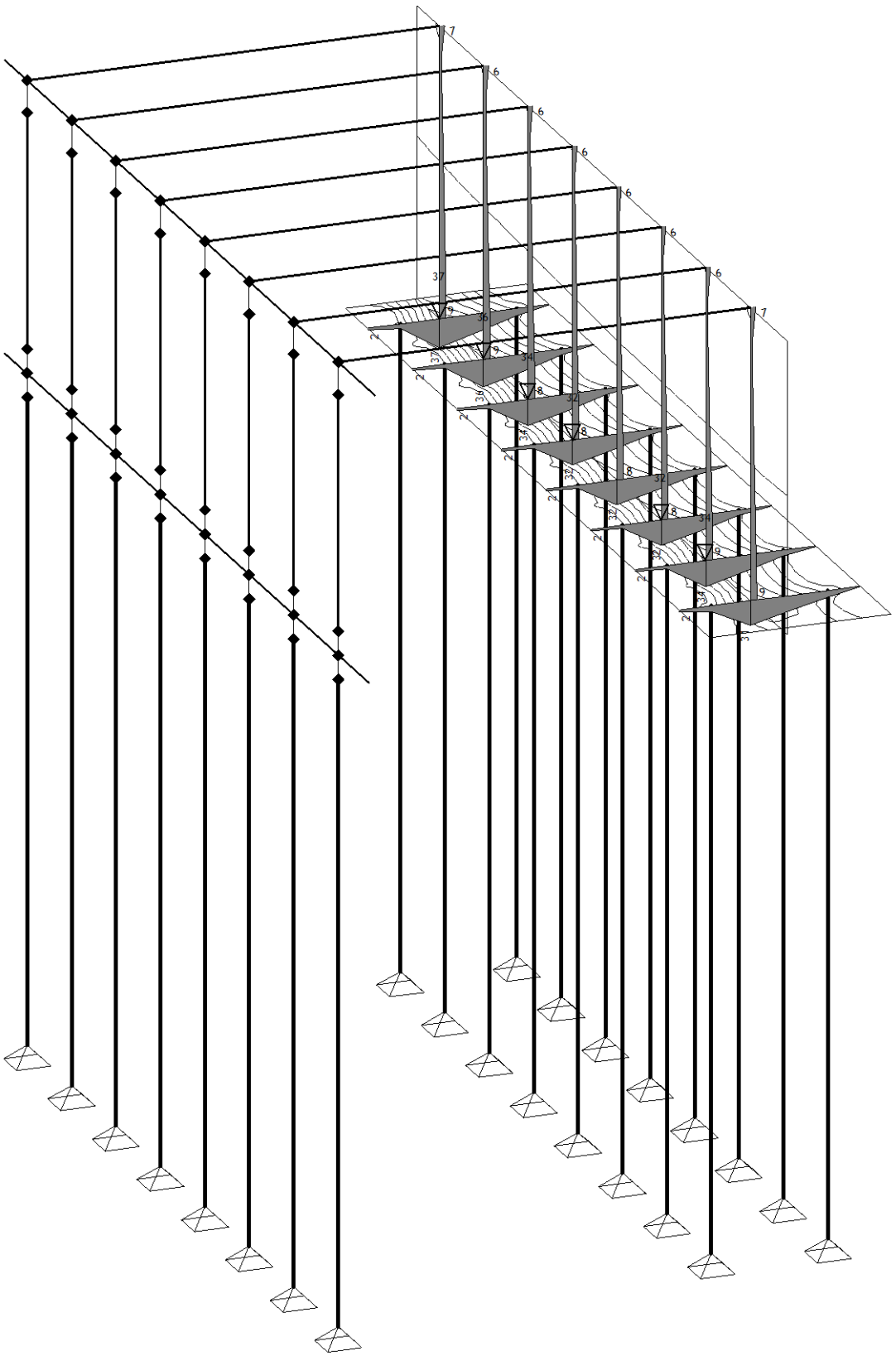
Isometric
Slab Results: max Ny= 42 / min Ny= 0 kN/m

Load 7: Sz

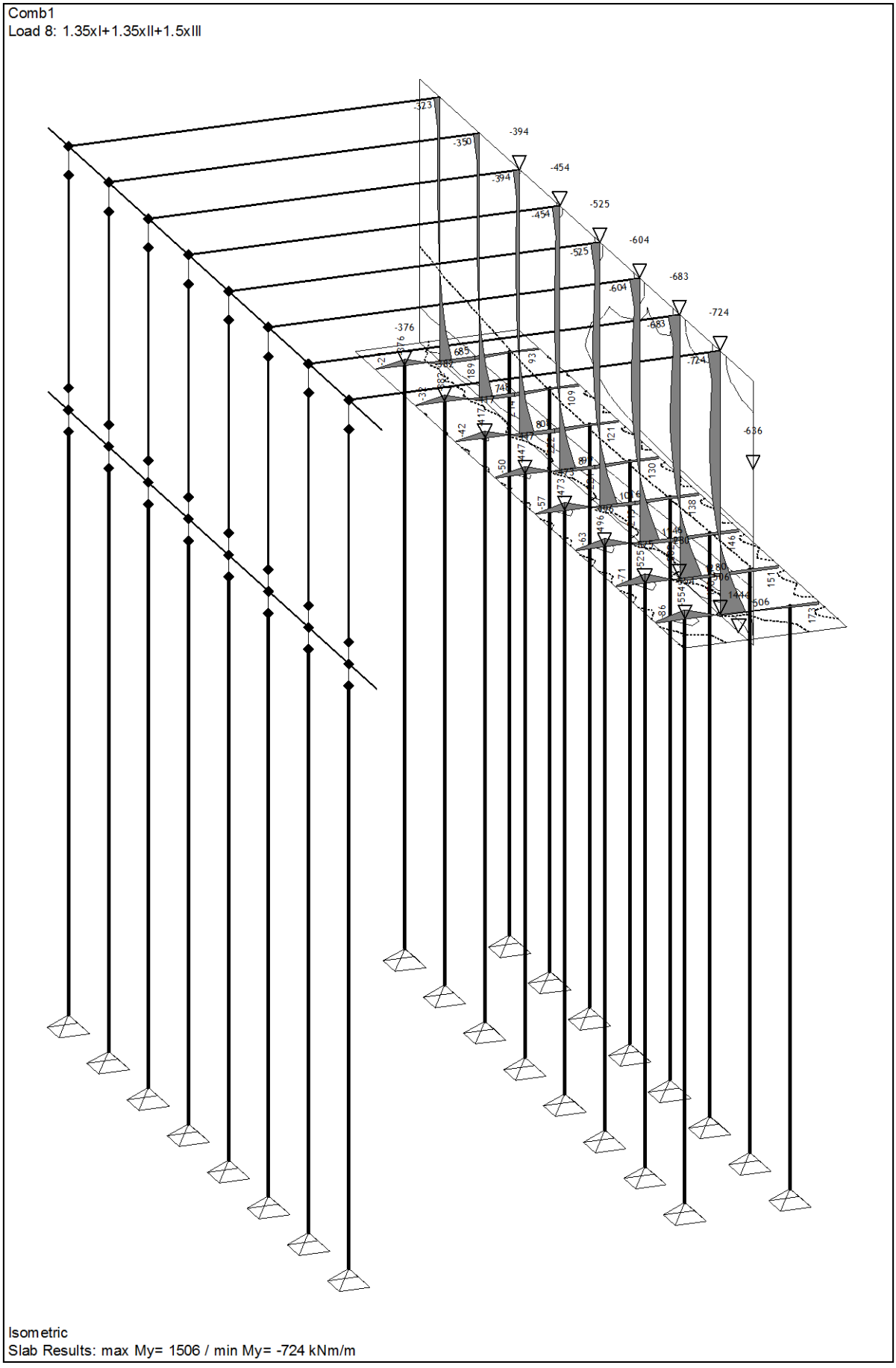


Isometric
Slab Results: max Ny= 47 / min Ny= 0 kN/m

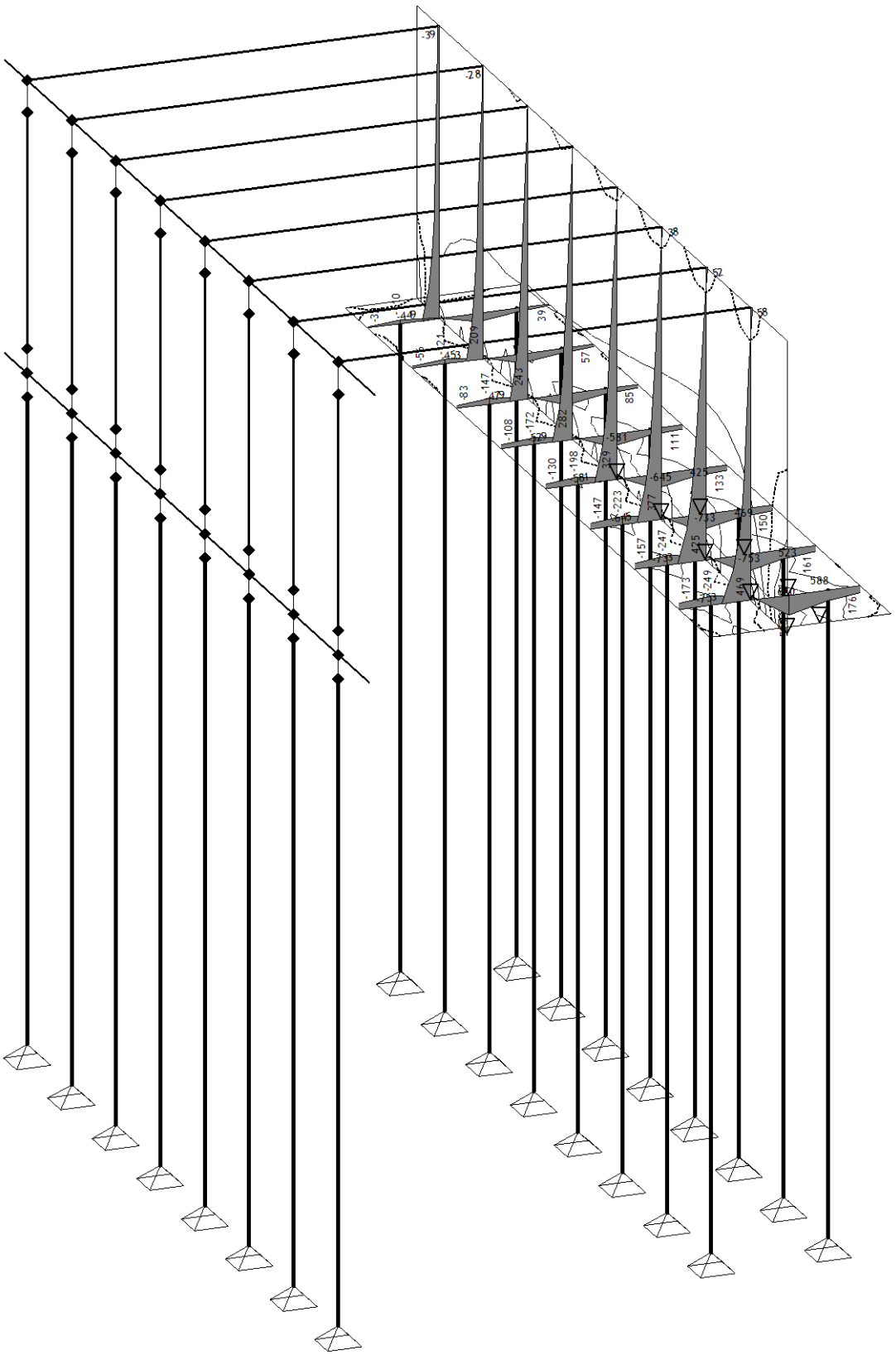
Load 7: Sz



Isometric
Slab Results: max My= 37 / min My= 0 kNm/m

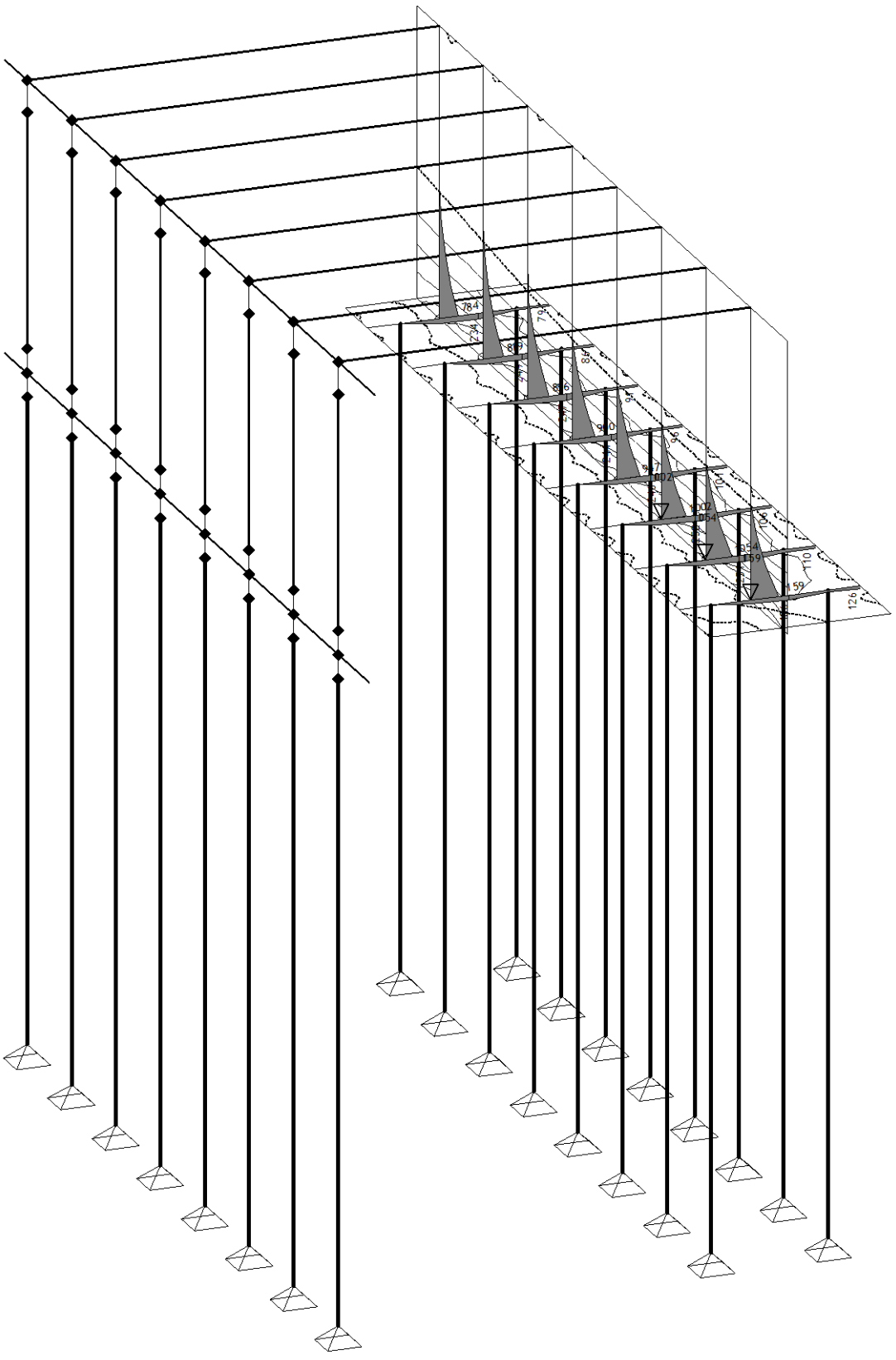

Comb1
Load 8: 1.35xI+1.35xII+1.5xIII
-323
-350
-394
-454
-525
-604
-683
-724
-376
-636
Isometric
Slab Results: max My= 1506 / min My= -724 kNm/m

Comb1
Load 8: 1.35xI+1.35xII+1.5xIII



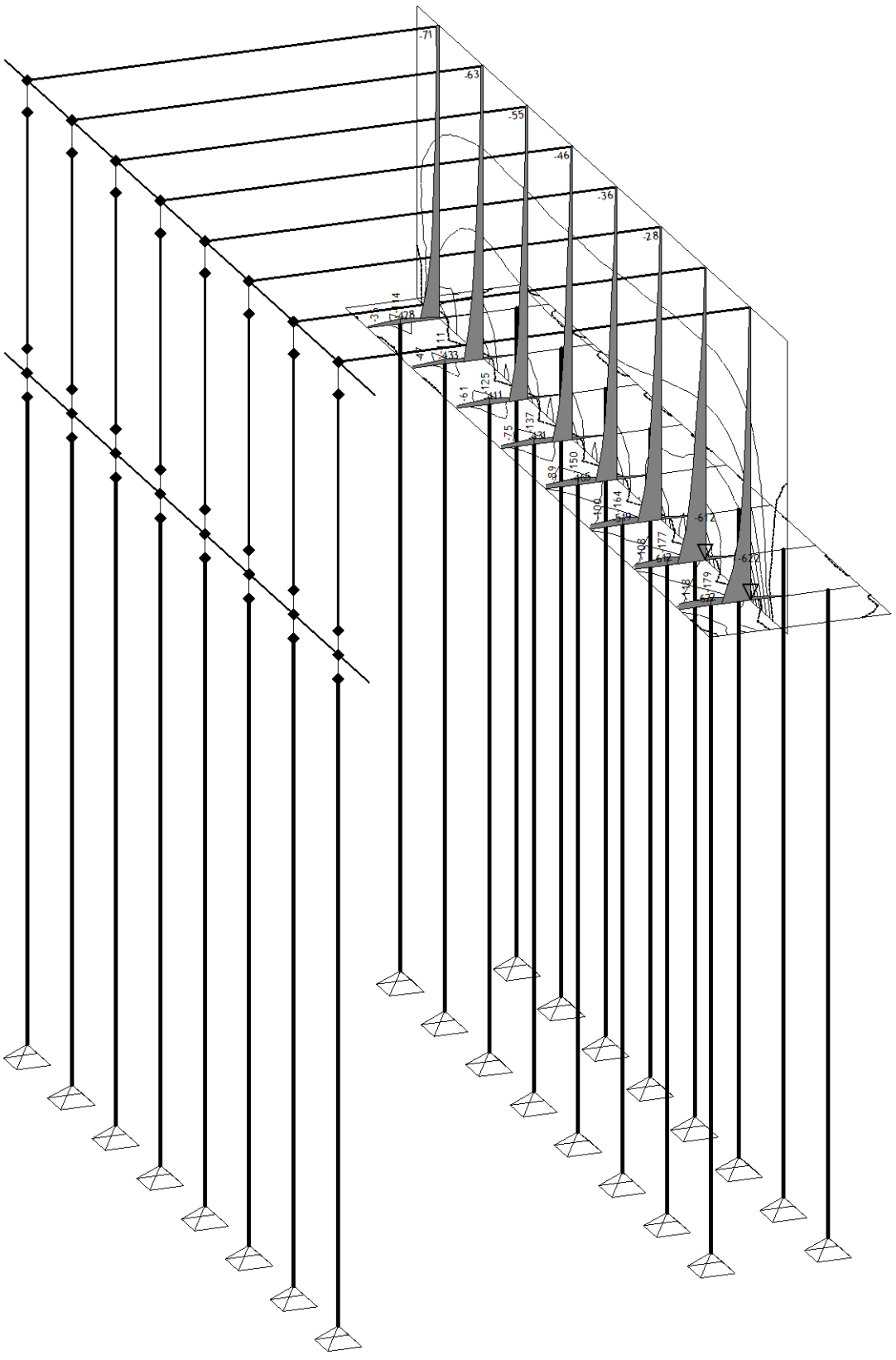
Isometric
Slab Results: max Ny= 620 / min Ny= -753 kN/m

Comb2
Load 12: [Anv] 9-11



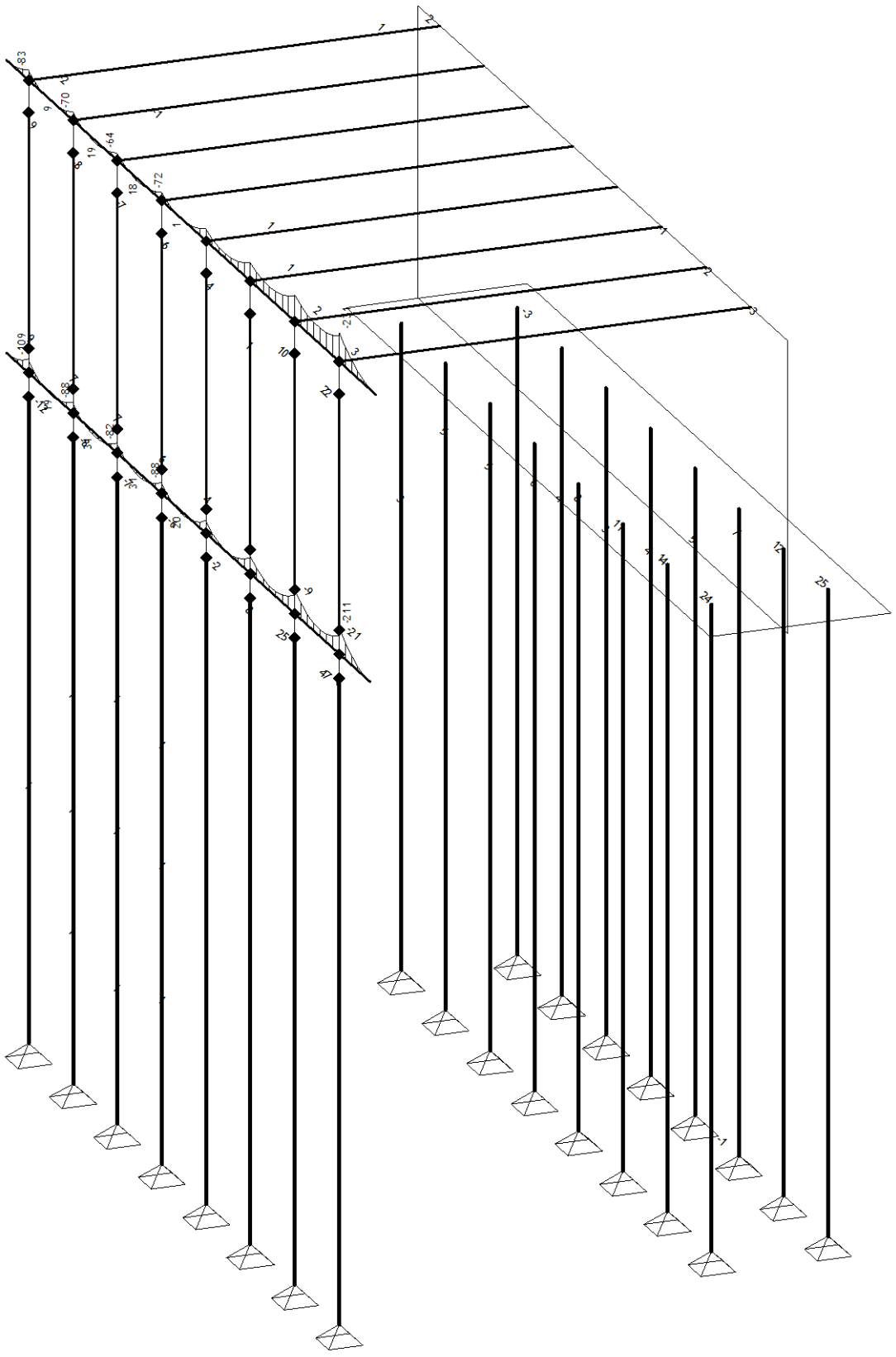
Isometric
Slab Results: max My= 1159 / min My= 0 kNm/m

Comb2
Load 12: [Anv] 9-11



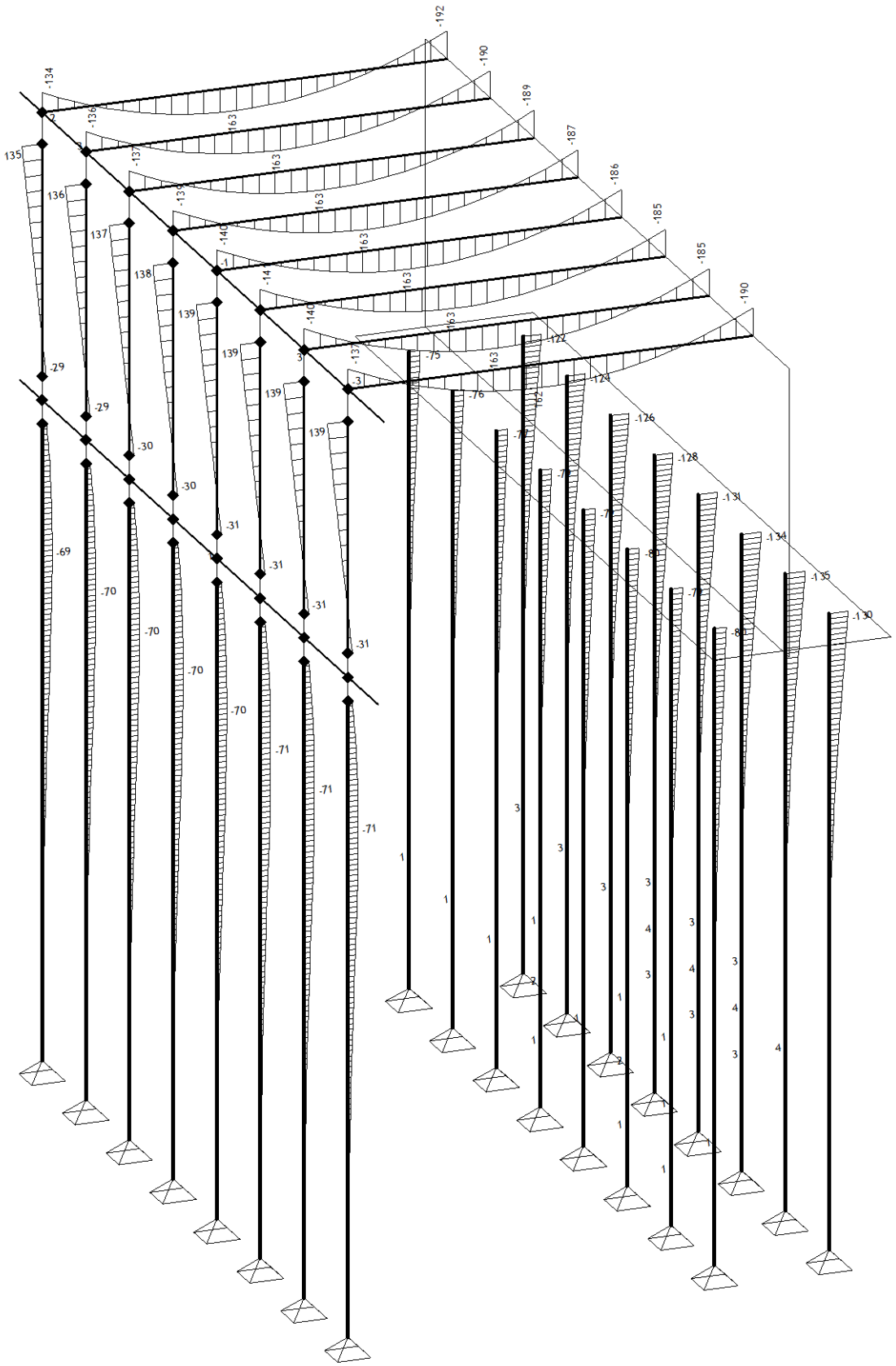
Isometric
Slab Results: max Ny= 0 / min Ny= -622 kN/m

Load 1: Sopstvena tezina (g)



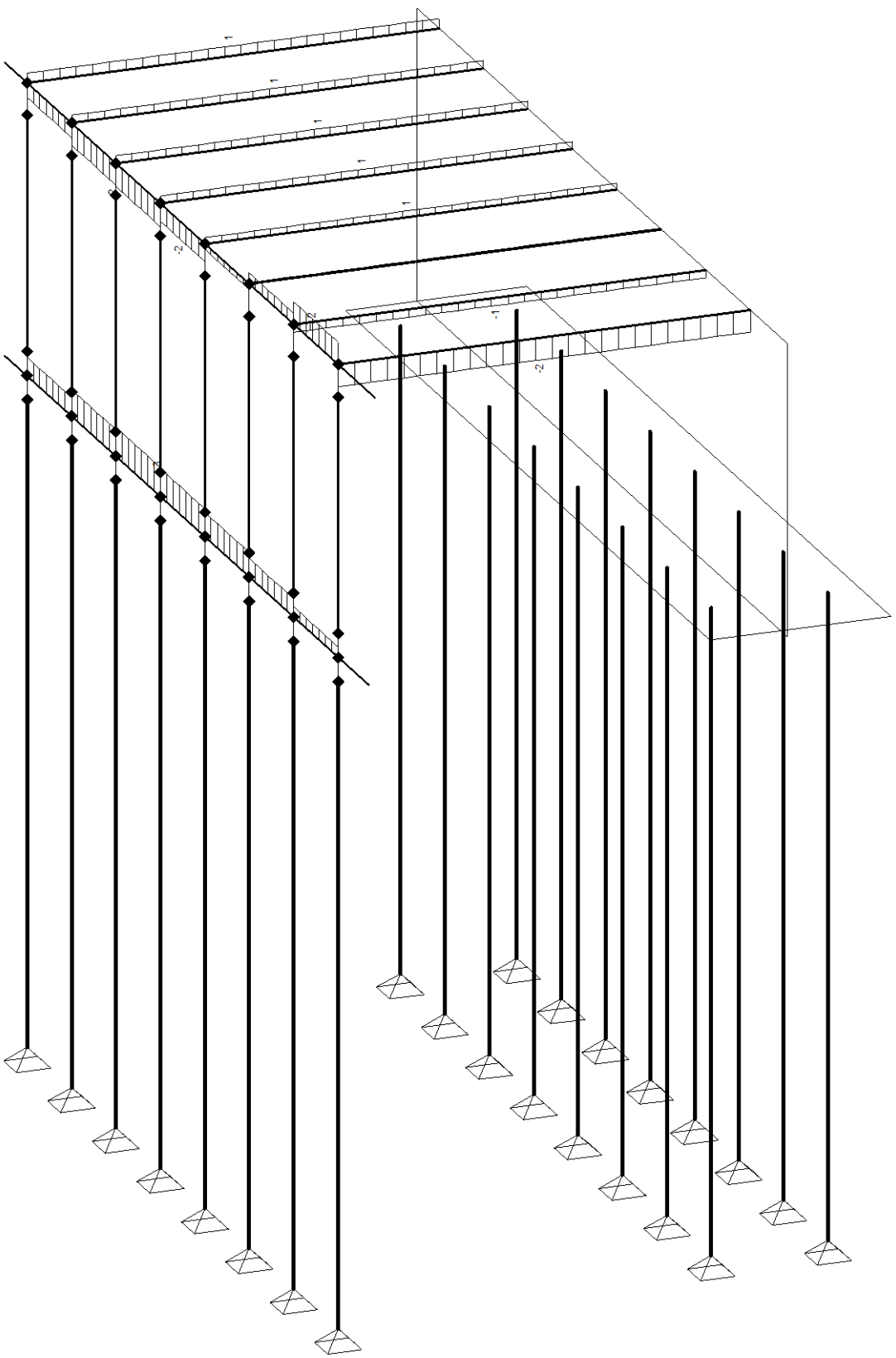
Isometric
Beam Results: max M3= 47 / min M3= -231 kNm

Load 1: Sopstvena tezina (g)



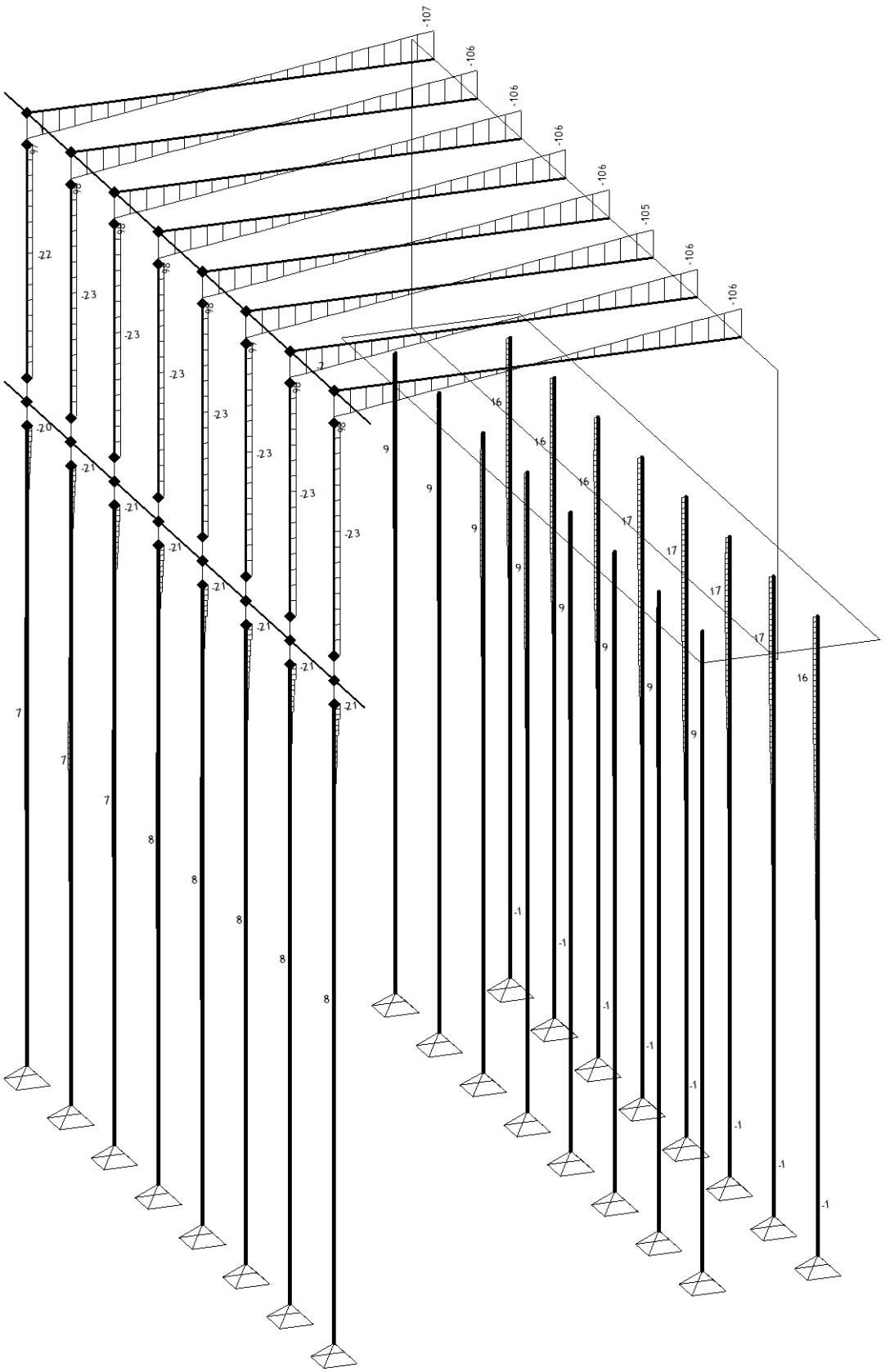
Isometric
Beam Results: max M2= 163 / min M2= -192 kNm

Load 1: Sopstvena tezina (g)



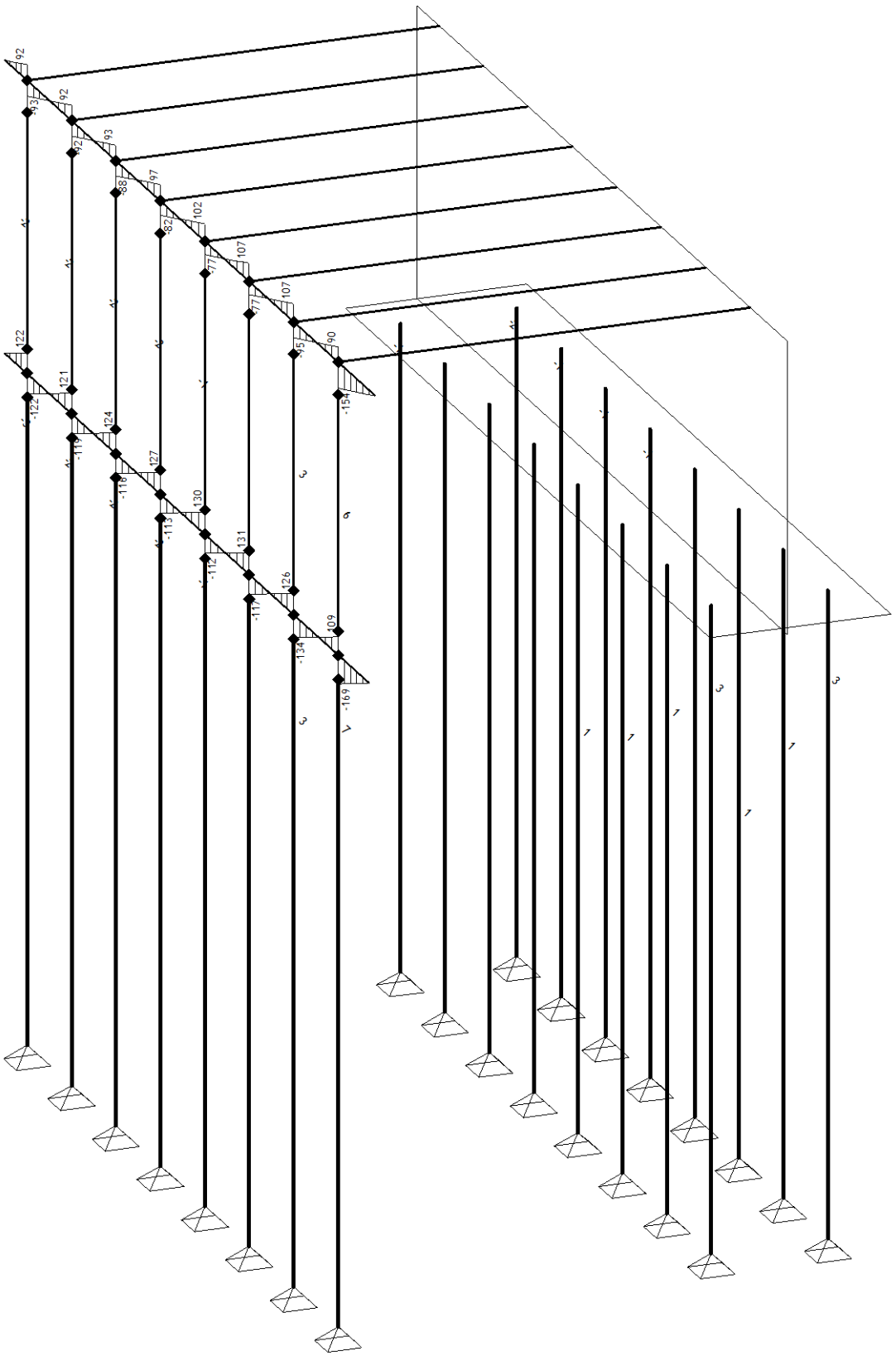
Isometric
Beam Results: max M1= 3 / min M1= -2 kNm

Load 1: Sopstvena tezina (g)



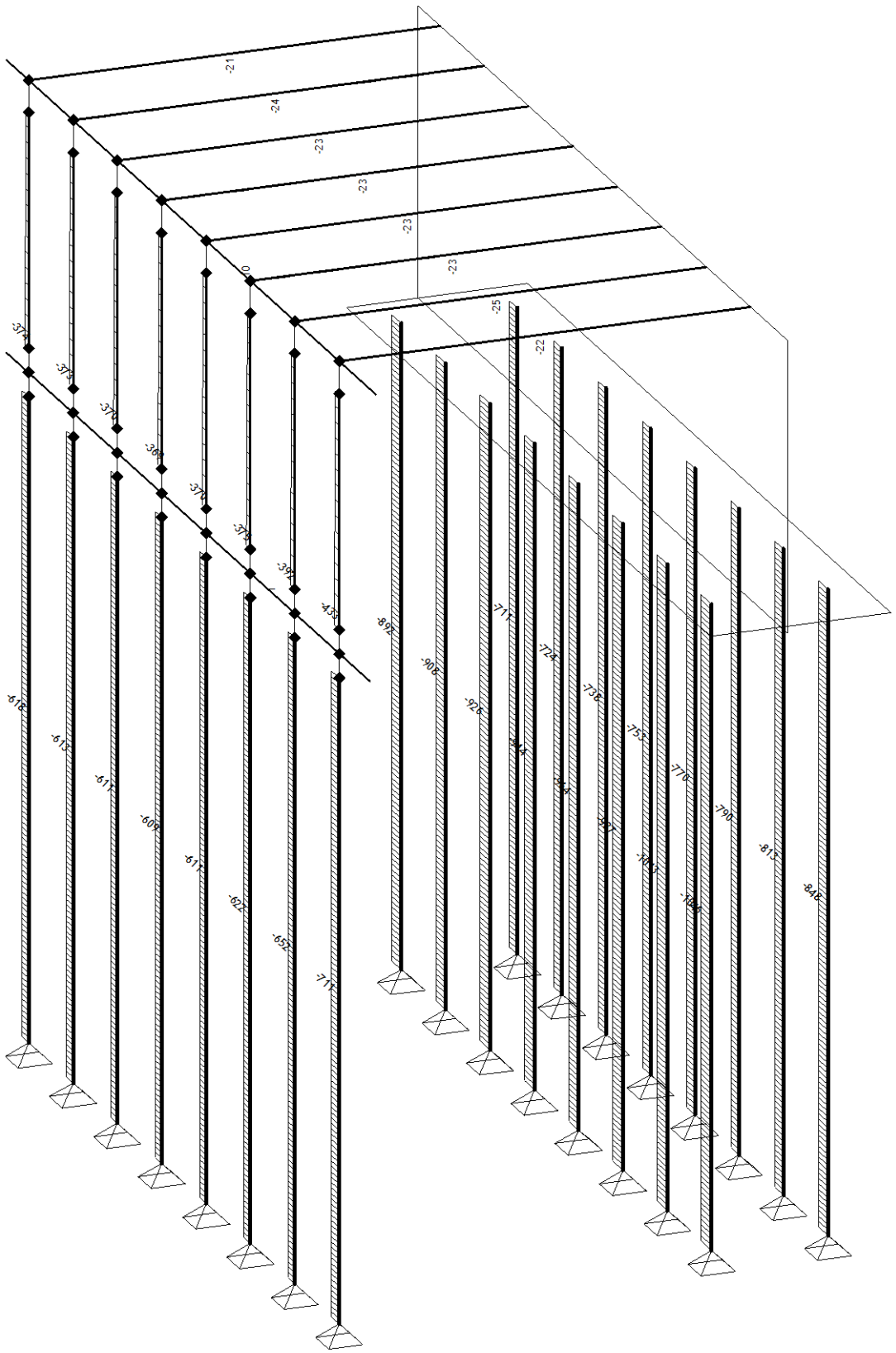
Isometric
Beam Results: max V3= 99 / min V3= -107 kN

Load 1: Sopstvena tezina (g)



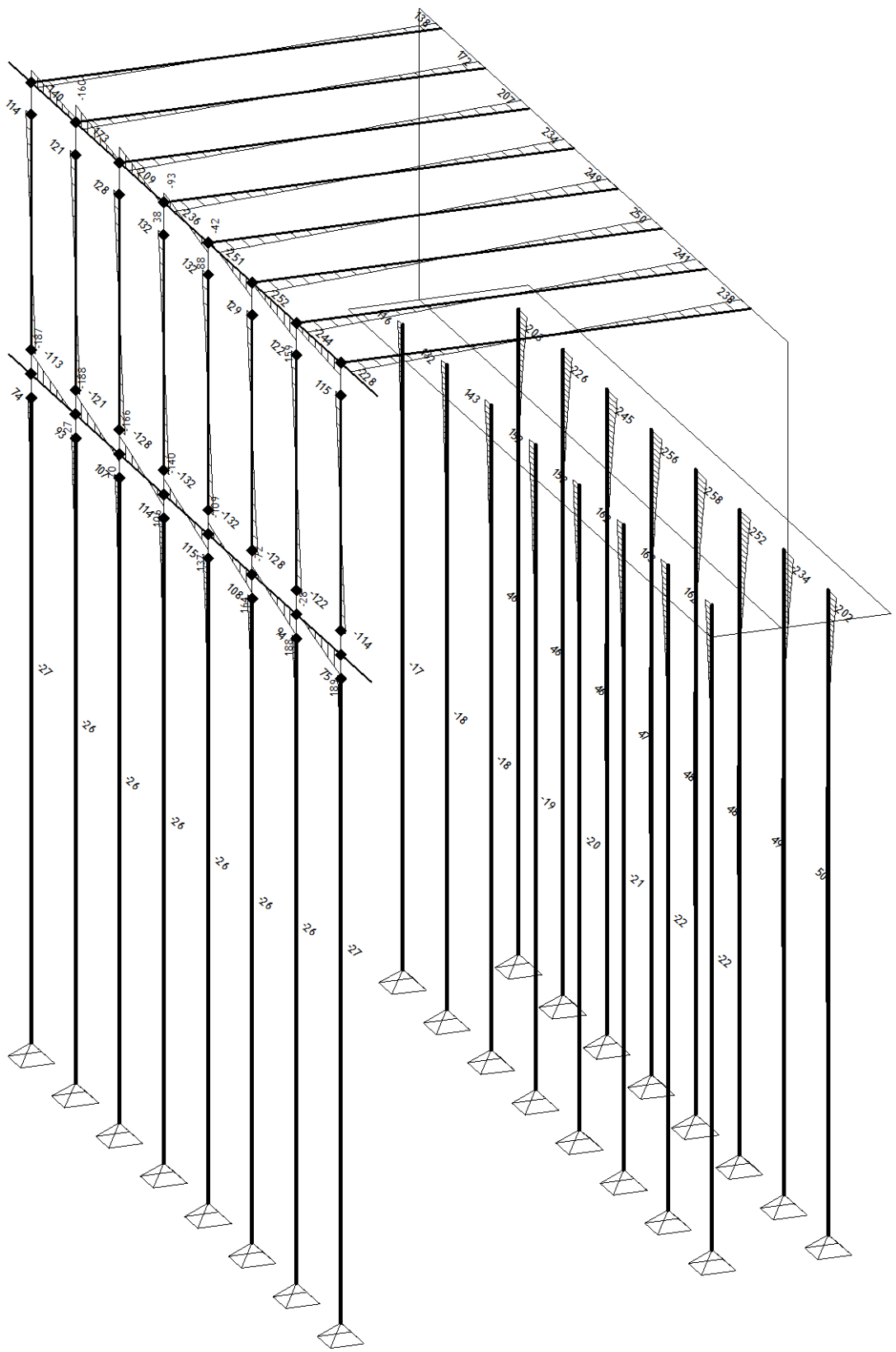
Isometric
Beam Results: max V2= 131 / min V2= -169 kN

Load 1: Sopstvena tezina (g)



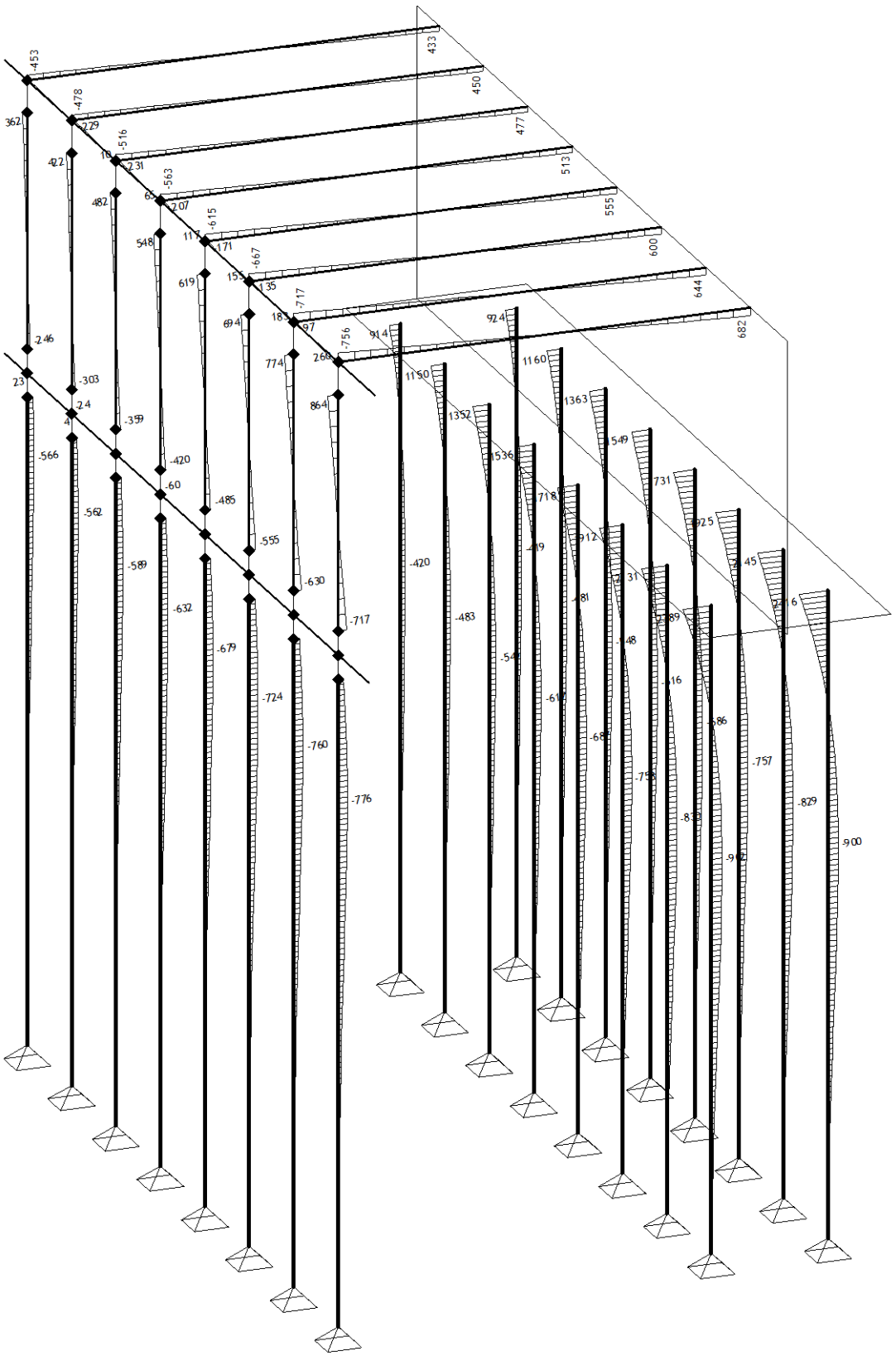
Isometric
Beam Results: max N1= 10 / min N1= -1046 kN

Load 2: Pritisak tla



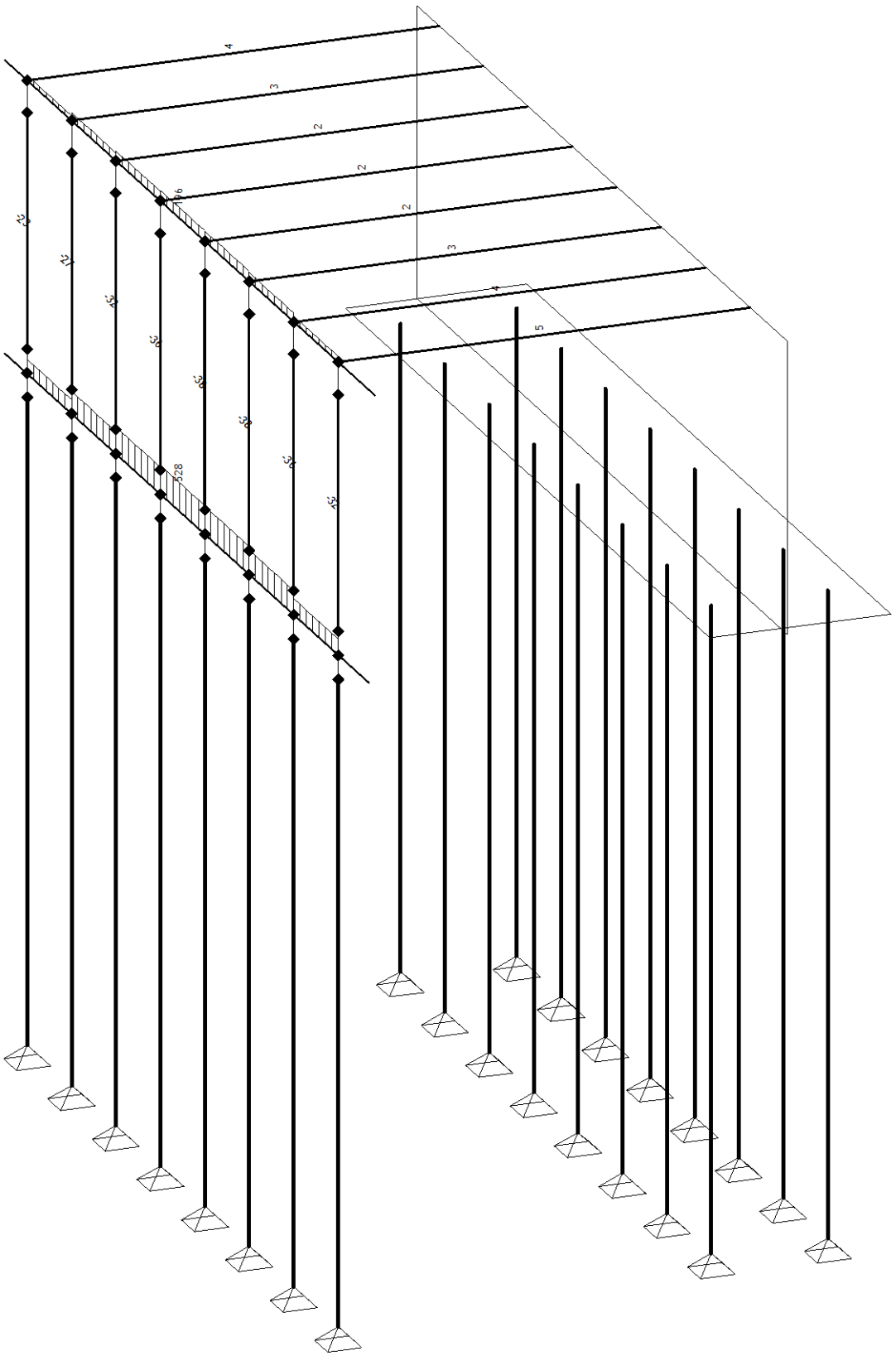
Isometric
Beam Results: max M3= 250 / min M3= -258 kNm

Load 2: Pritisak tla



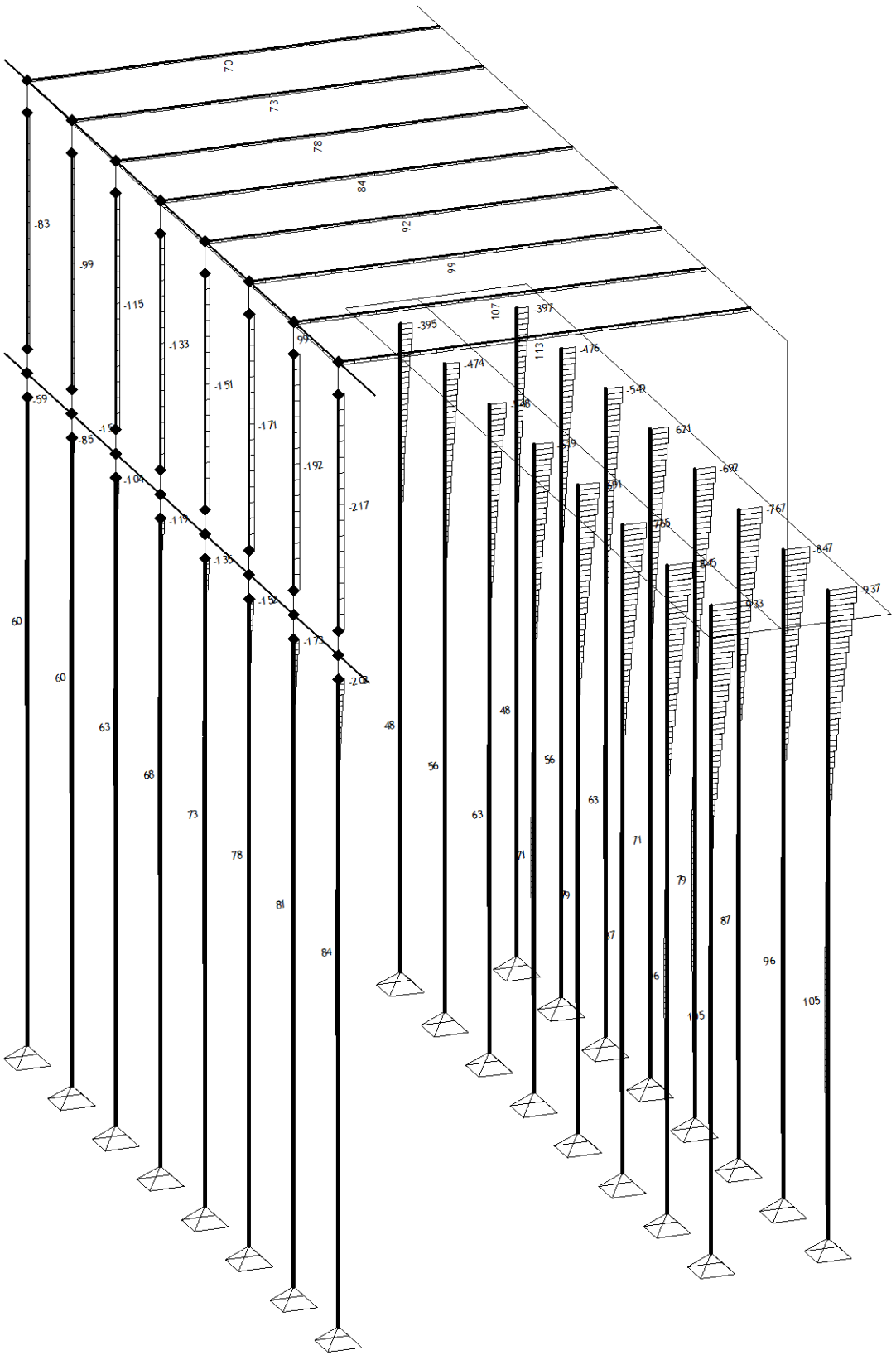
Isometric
Beam Results: max M2= 2416 / min M2= -902 kNm

Load 2: Pritisak tla



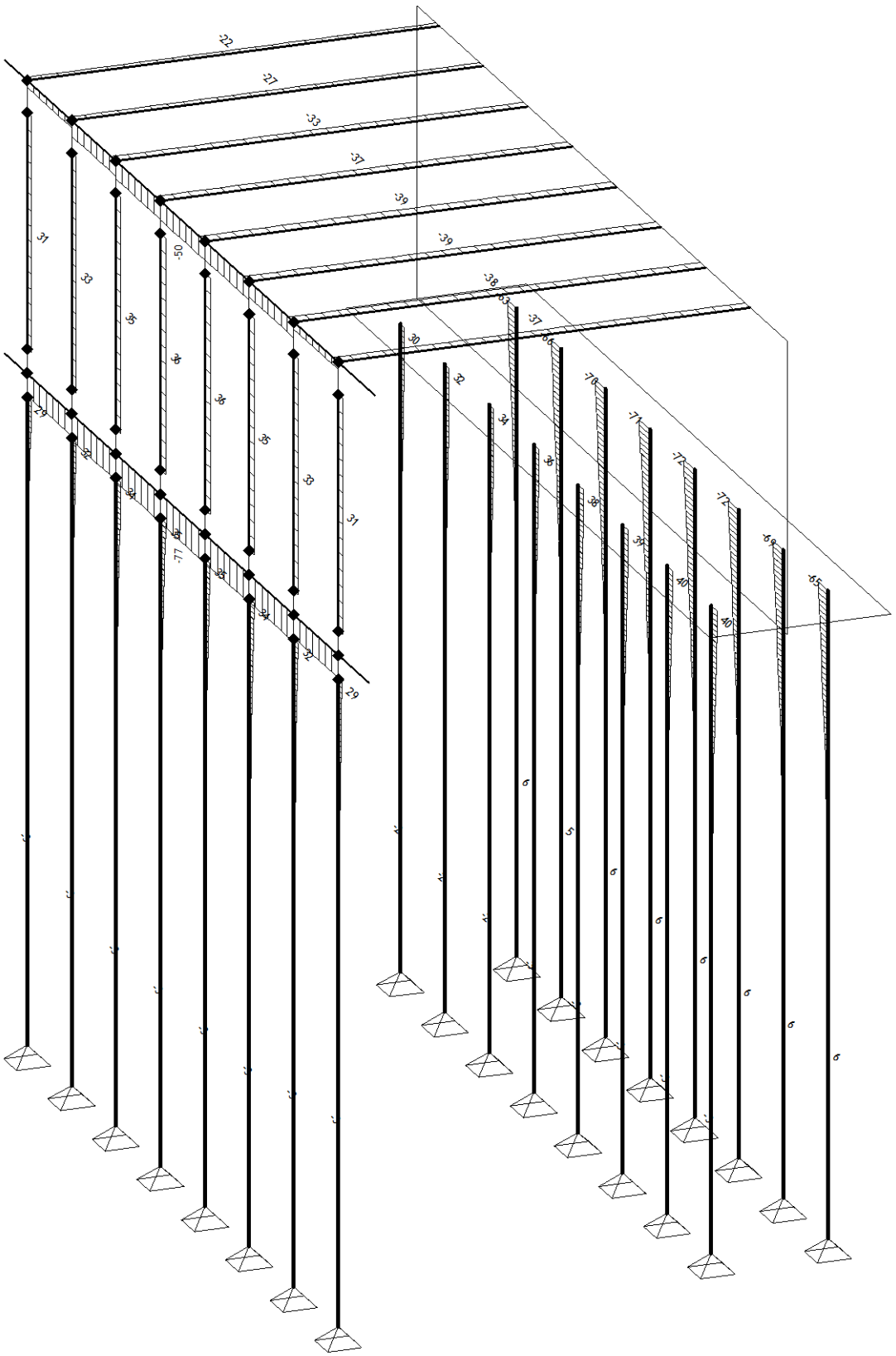
Isometric
Beam Results: max M1= 528 / min M1= -38 kNm

Load 2: Pritisak tla



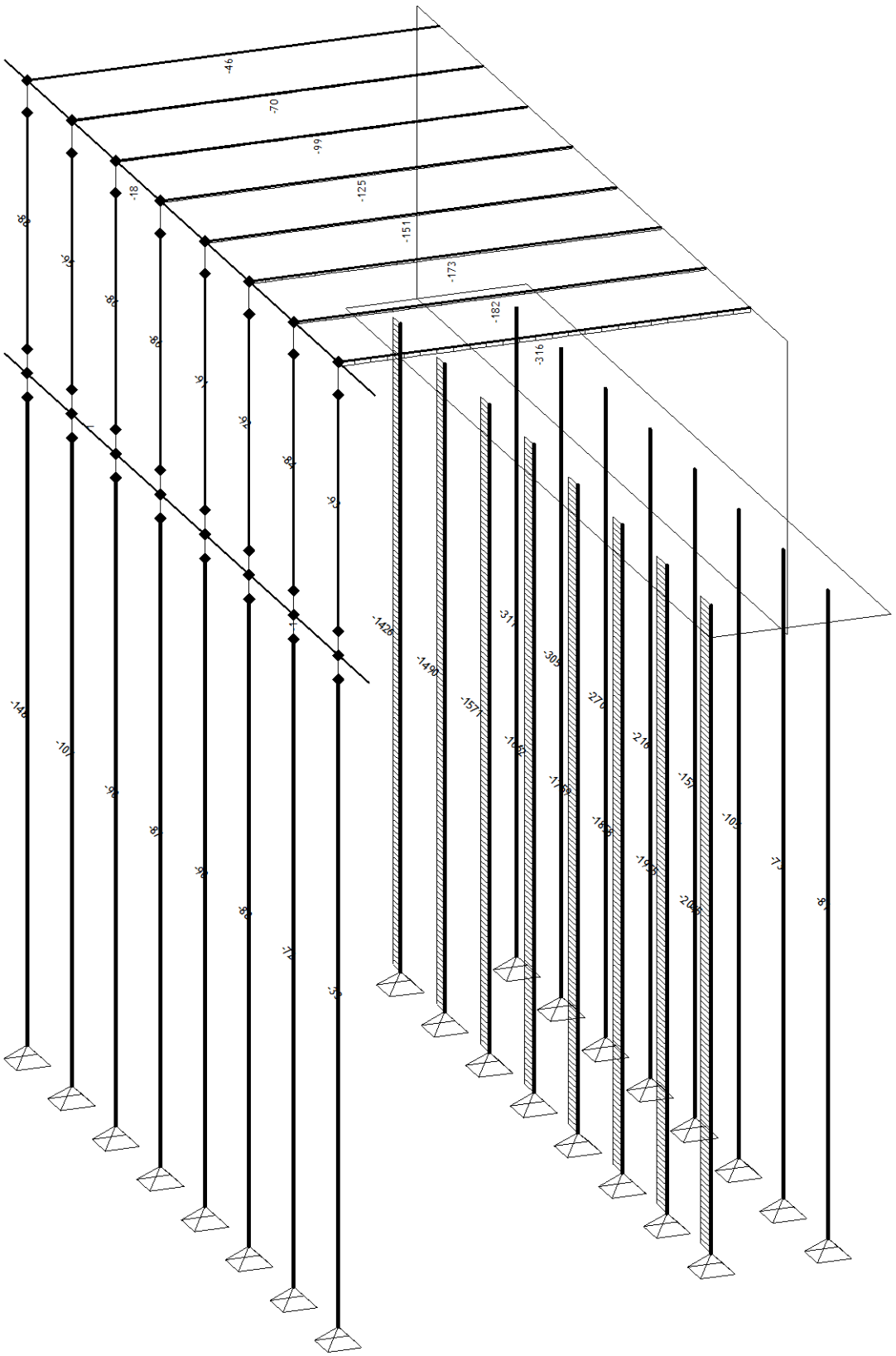
Isometric
Beam Results: max V3= 113 / min V3= -937 kN

Load 2: Pritisak tla



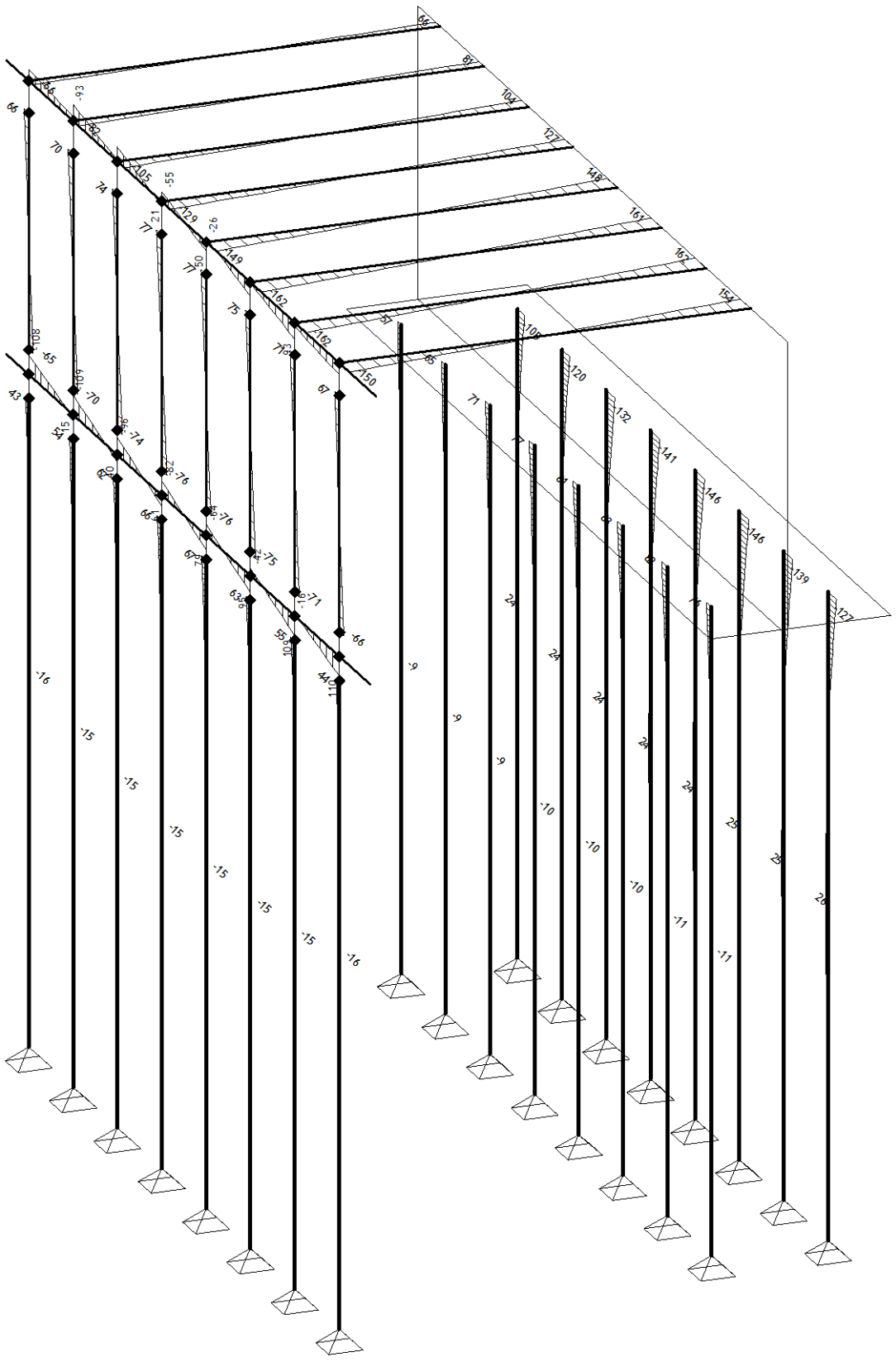
Isometric
Beam Results: max V2= 40 / min V2= -77 kN

Load 2: Pritisak tla



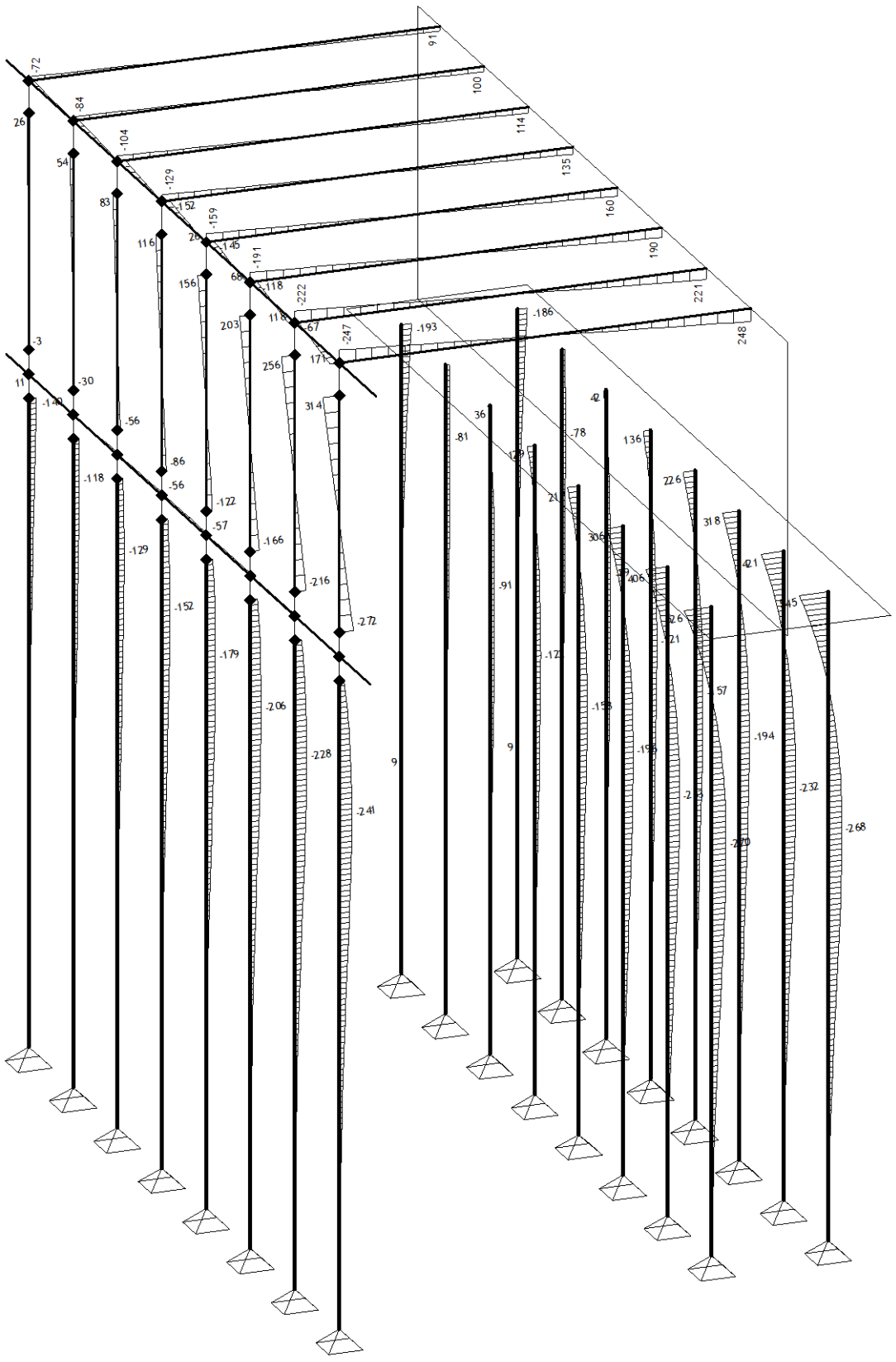
Isometric
Beam Results: max N1= 1 / min N1= -2045 kN

Load 3: Voz na nasipu



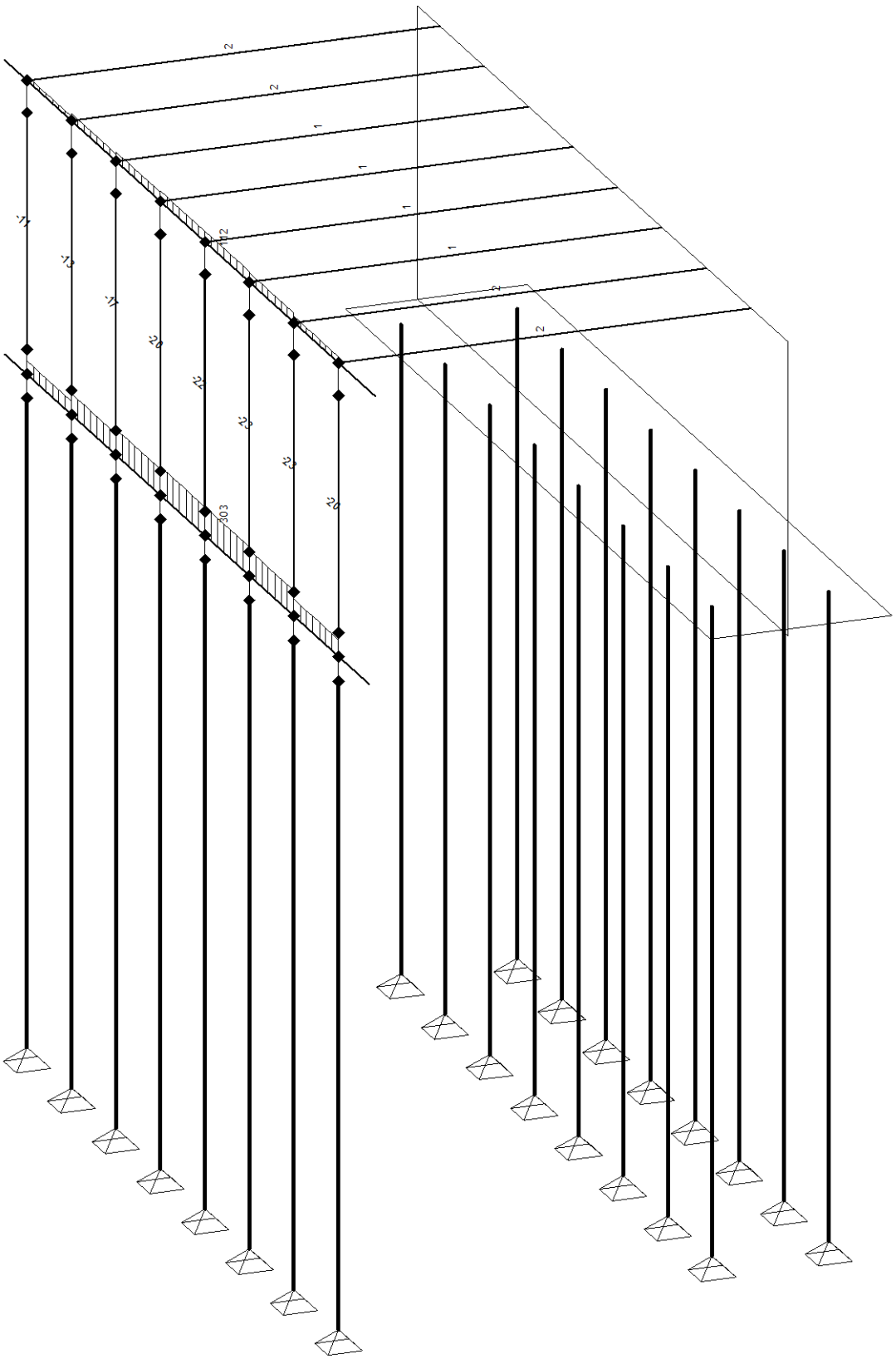
Isometric
Beam Results: max M3= 162 / min M3= -162 kNm

Load 3: Voz na nasipu



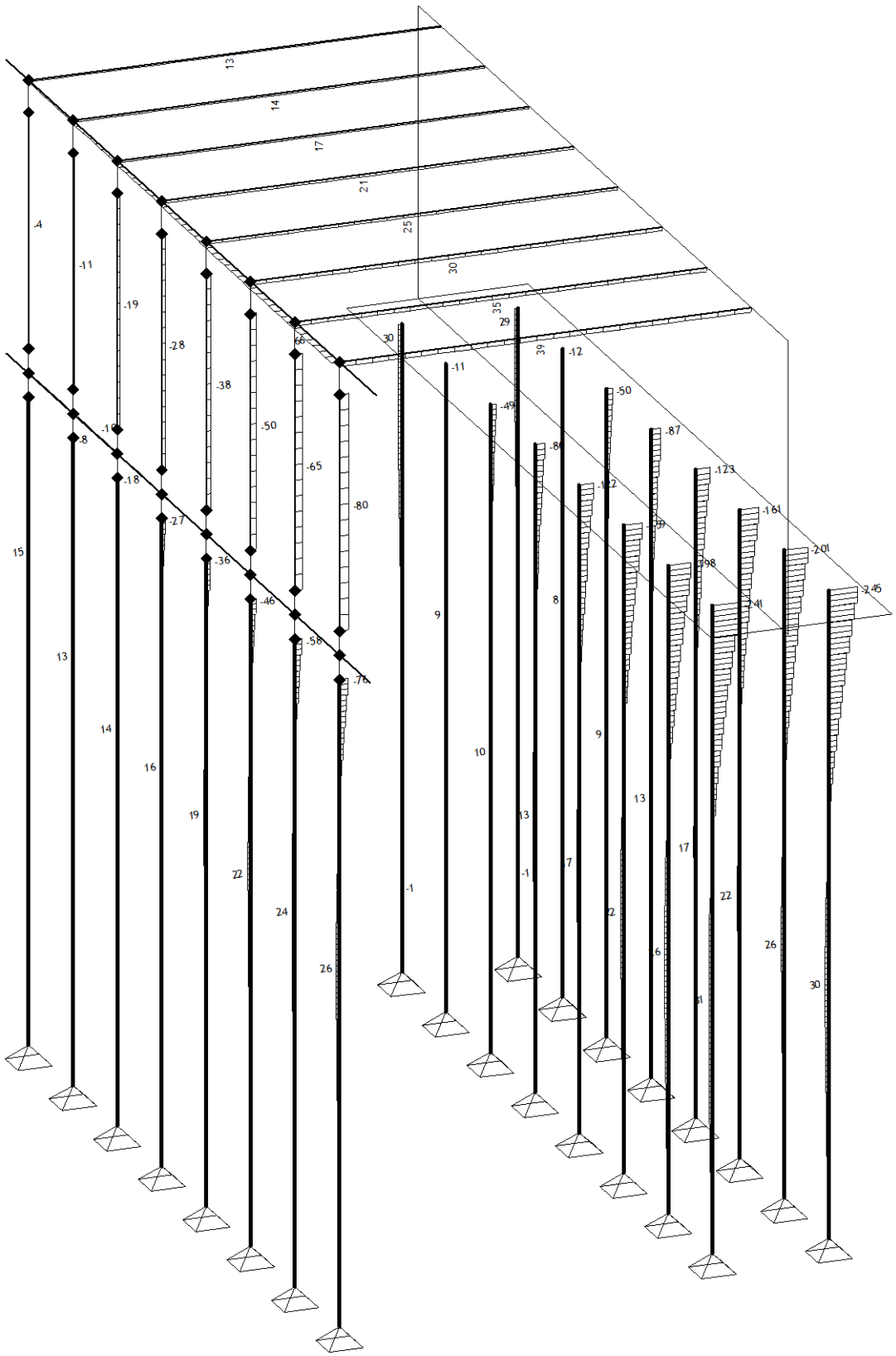
Isometric
Beam Results: max M2= 545 / min M2= -272 kNm

Load 3: Voz na nasipu



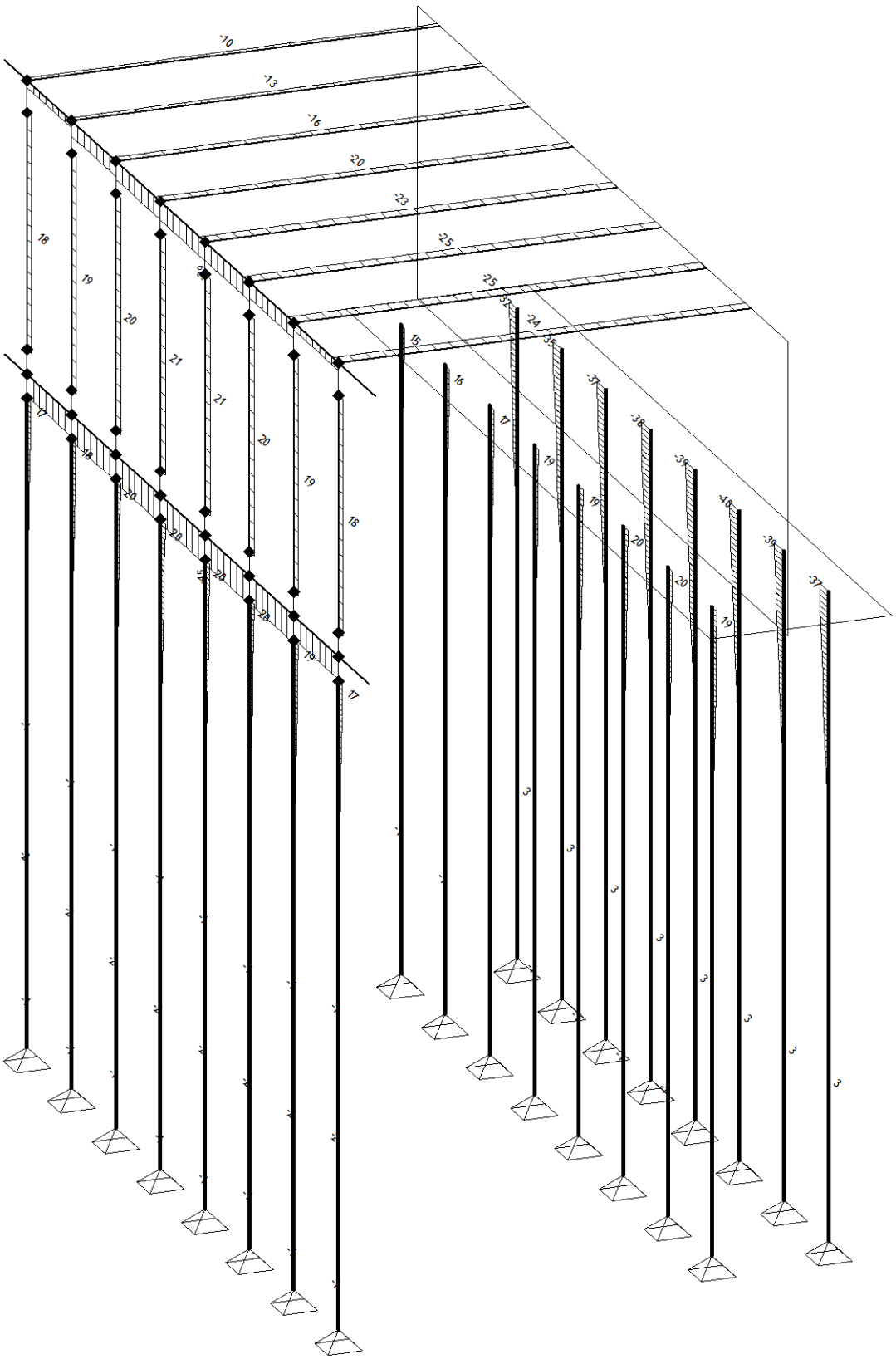
Isometric
Beam Results: max M1= 303 / min M1= -23 kNm

Load 3: Voz na nasipu



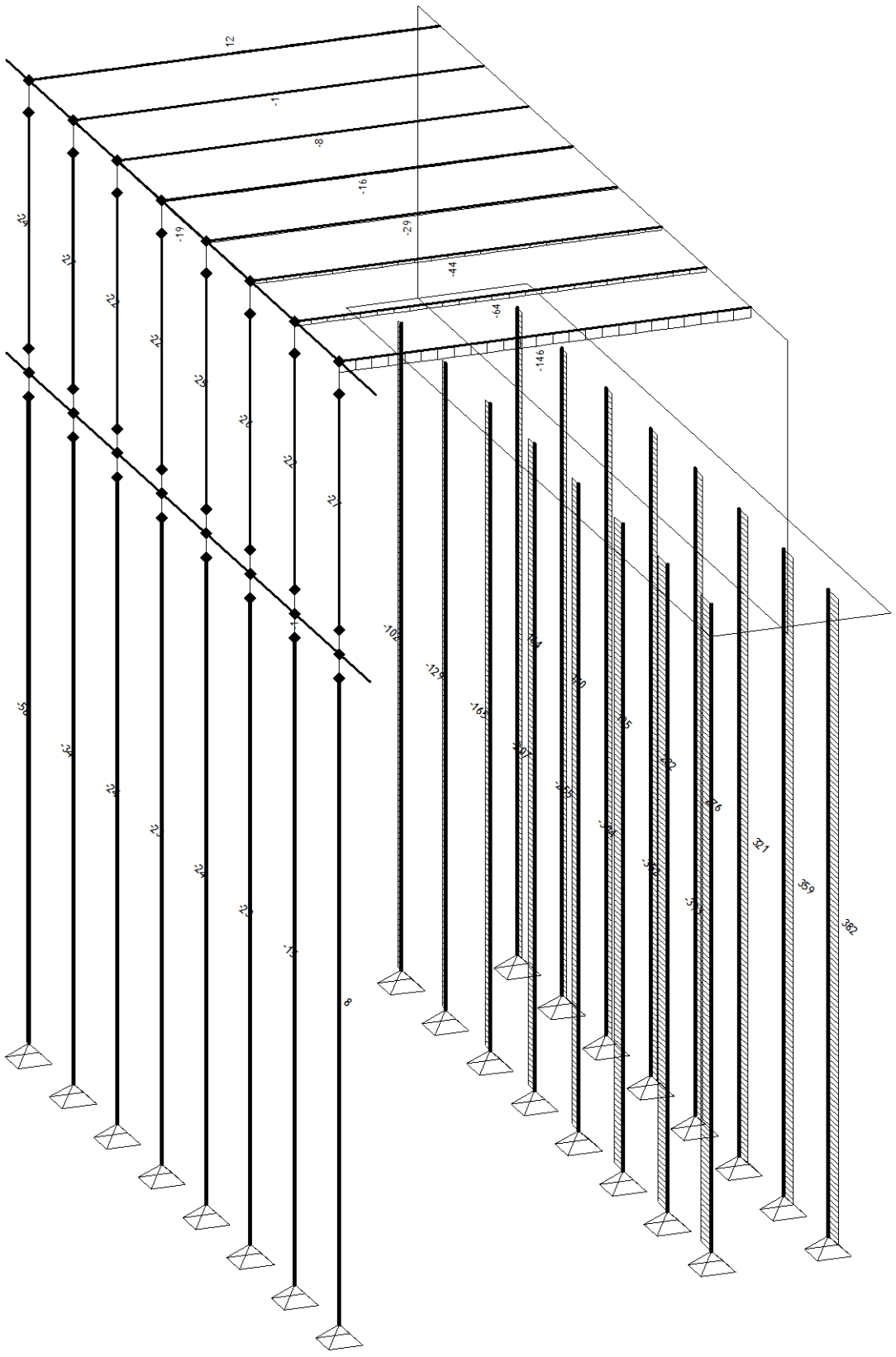
Isometric
Beam Results: max V3= 66 / min V3= -245 kN

Load 3: Voz na nasipu



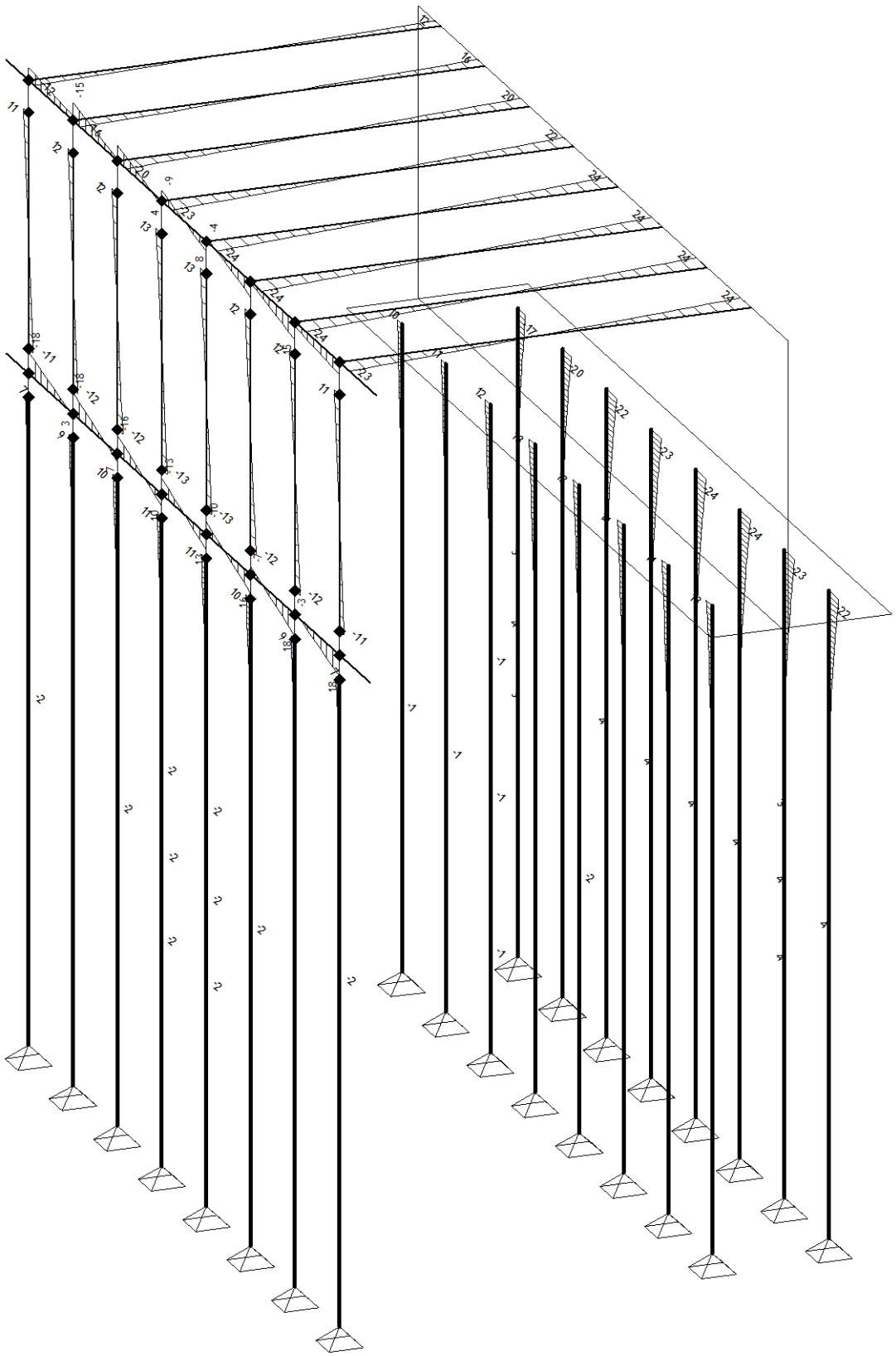
Isometric
Beam Results: max V2= 21 / min V2= -45 kN

Load 3: Voz na nasipu



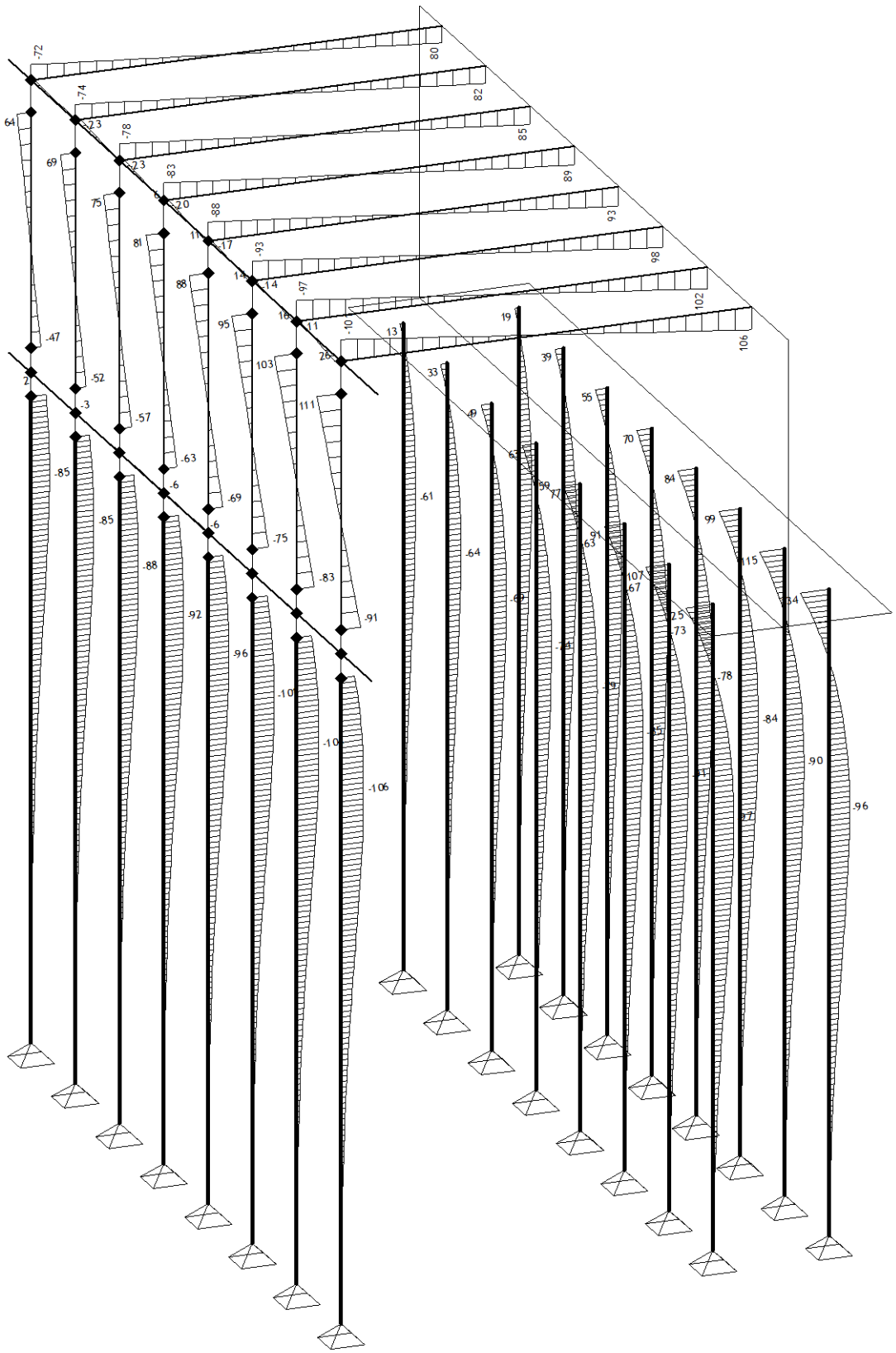
Isometric
Beam Results: max N1= 382 / min N1= -393 kN

Load 4: Seizmicki pritisak tla



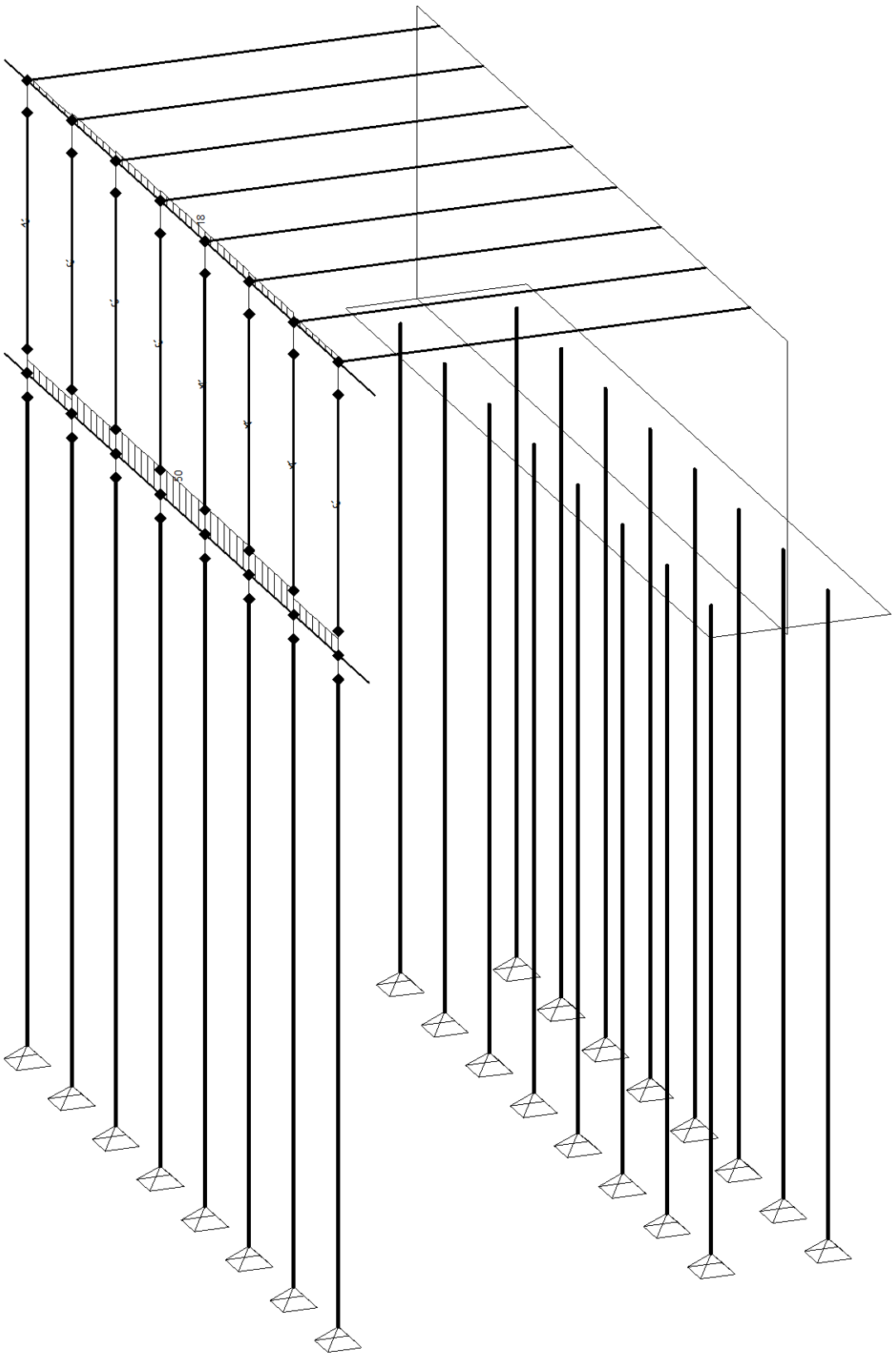
Isometric
Beam Results: max M3= 24 / min M3= -24 kNm

Load 4: Seizmicki pritisak tla



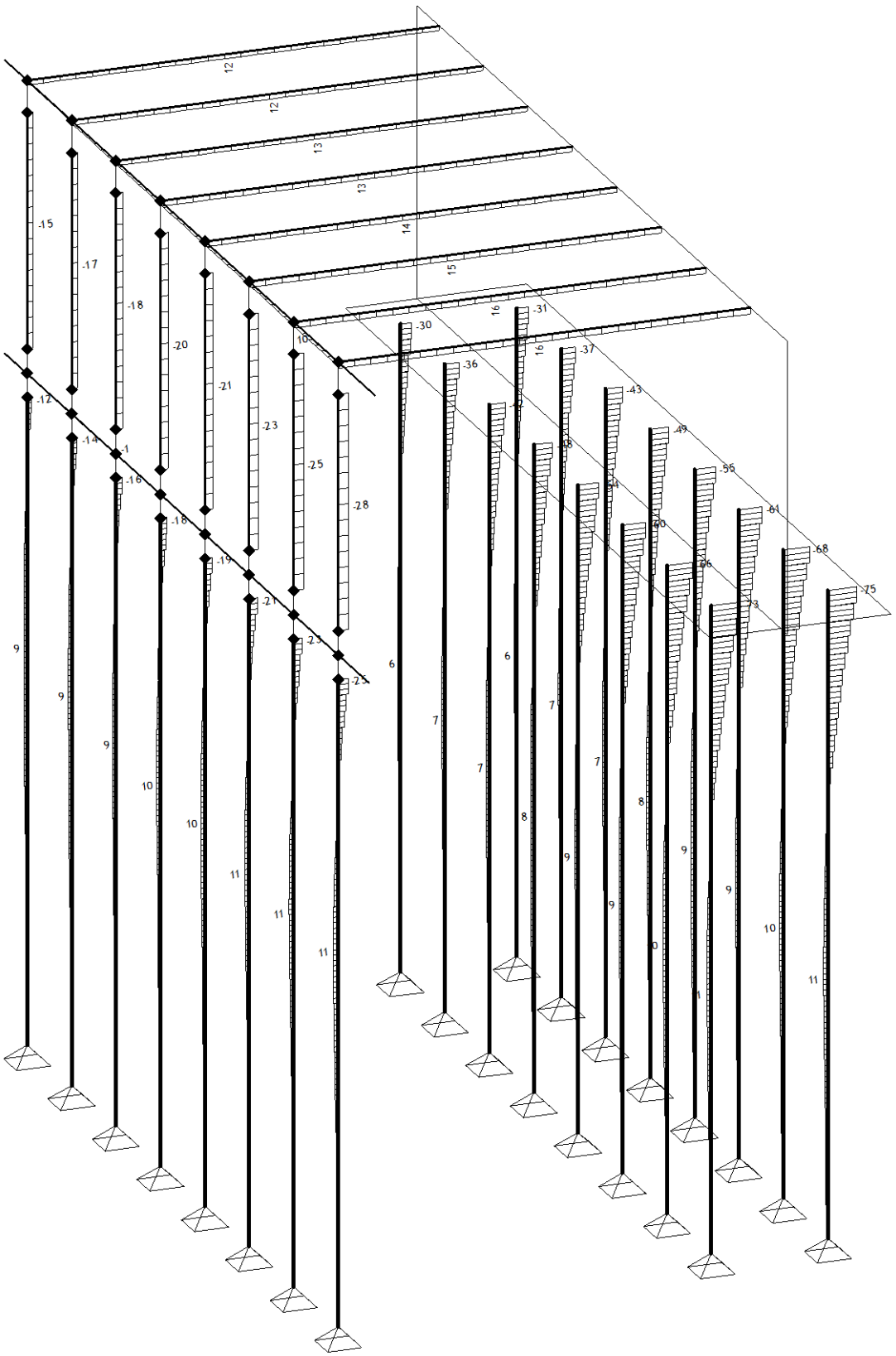
Isometric
Beam Results: max M2= 134 / min M2= -106 kNm

Load 4: Seizmicki pritisak tla



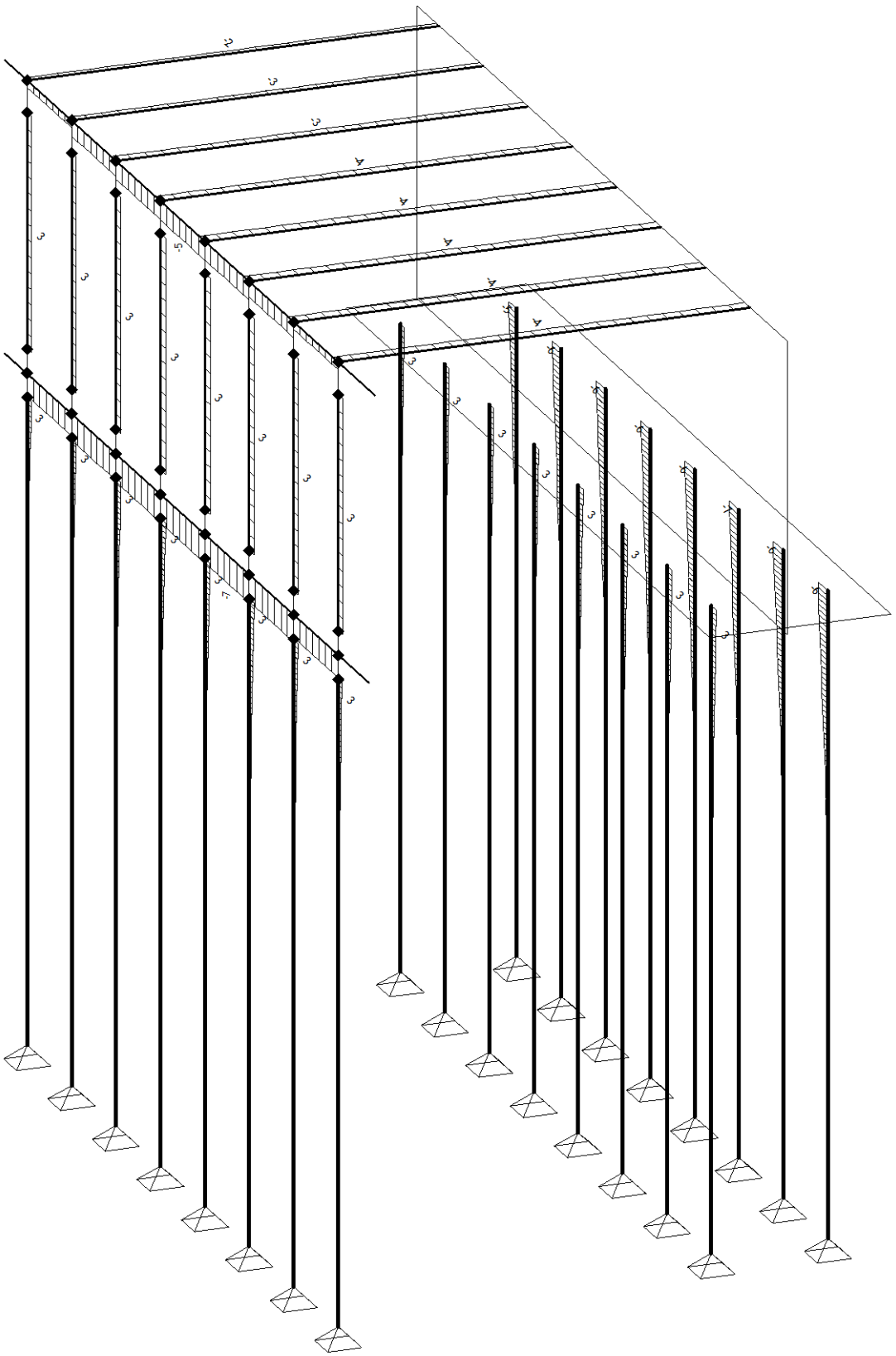
Isometric
Beam Results: max M1= 50 / min M1= -4 kNm

Load 4: Seizmicki pritisak tla



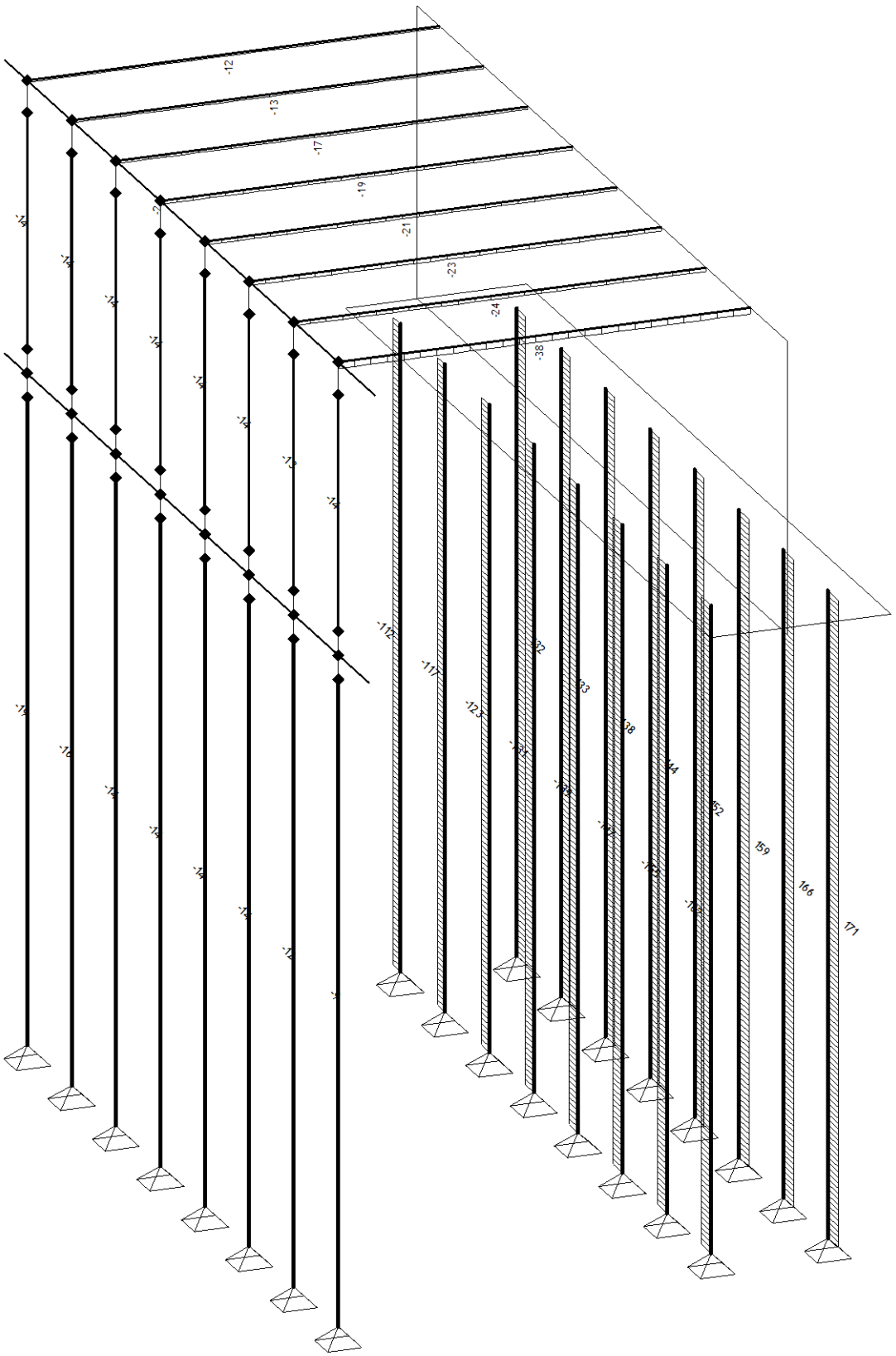
Isometric
Beam Results: max V3= 16 / min V3= -75 kN

Load 4: Seizmicki pritisak tla

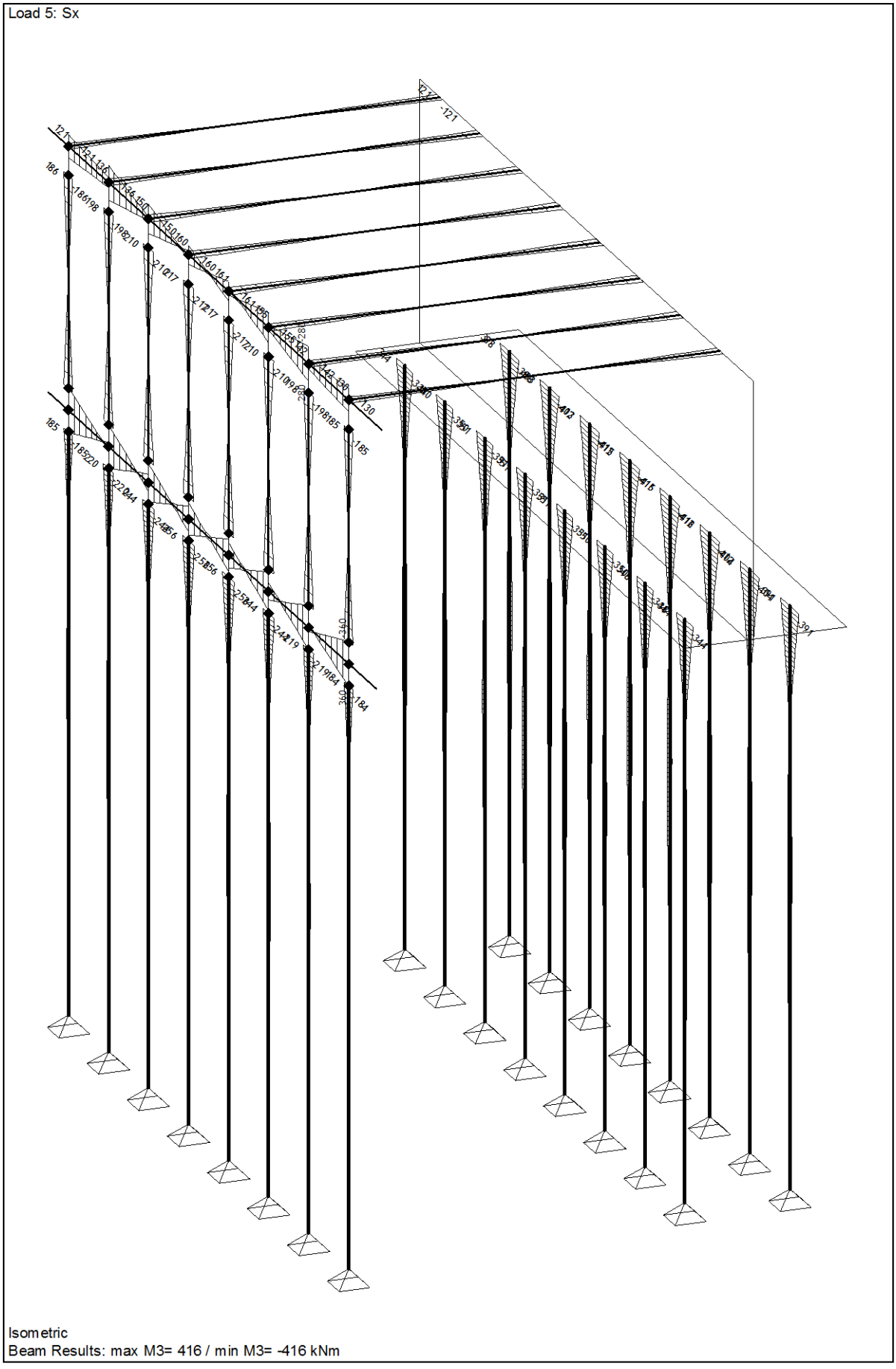


Isometric
Beam Results: max V2= 3 / min V2= -7 kN

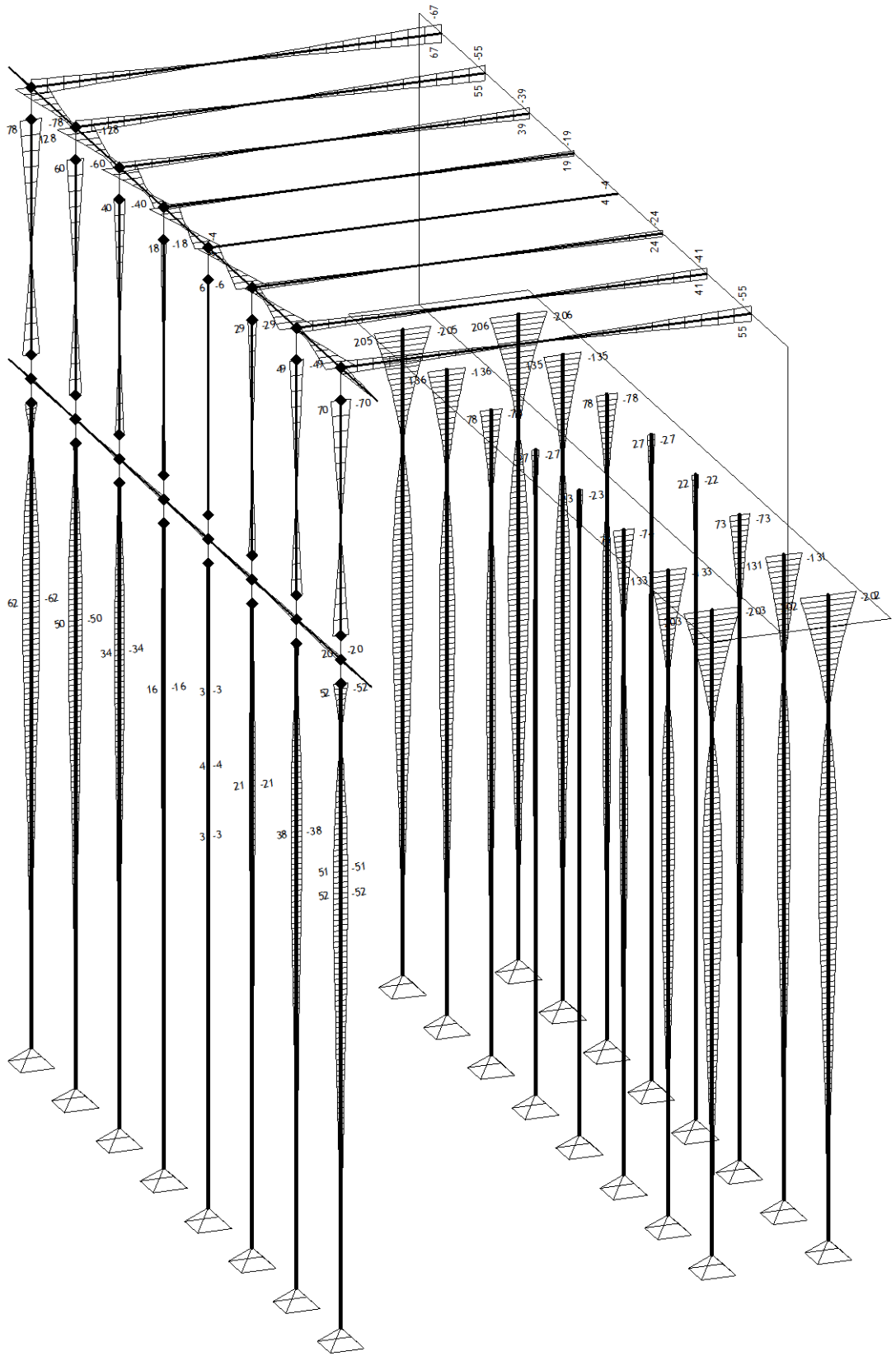
Load 4: Seizmicki pritisak tla



Isometric
Beam Results: max N1= 171 / min N1= -162 kN

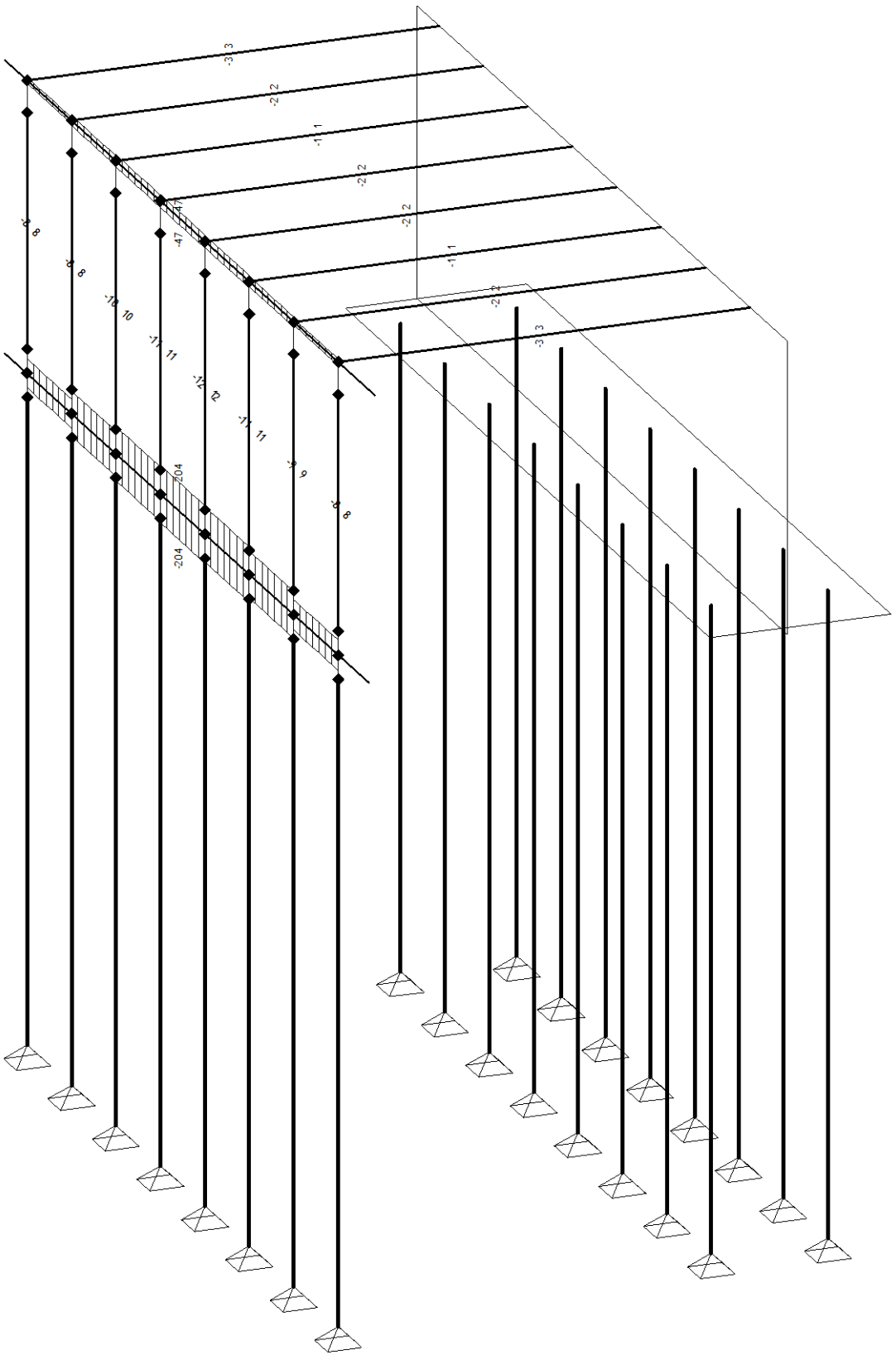

Load 5: Sx
Isometric
Beam Results: max M3= 416 / min M3= -416 kNm

Load 5: Sx



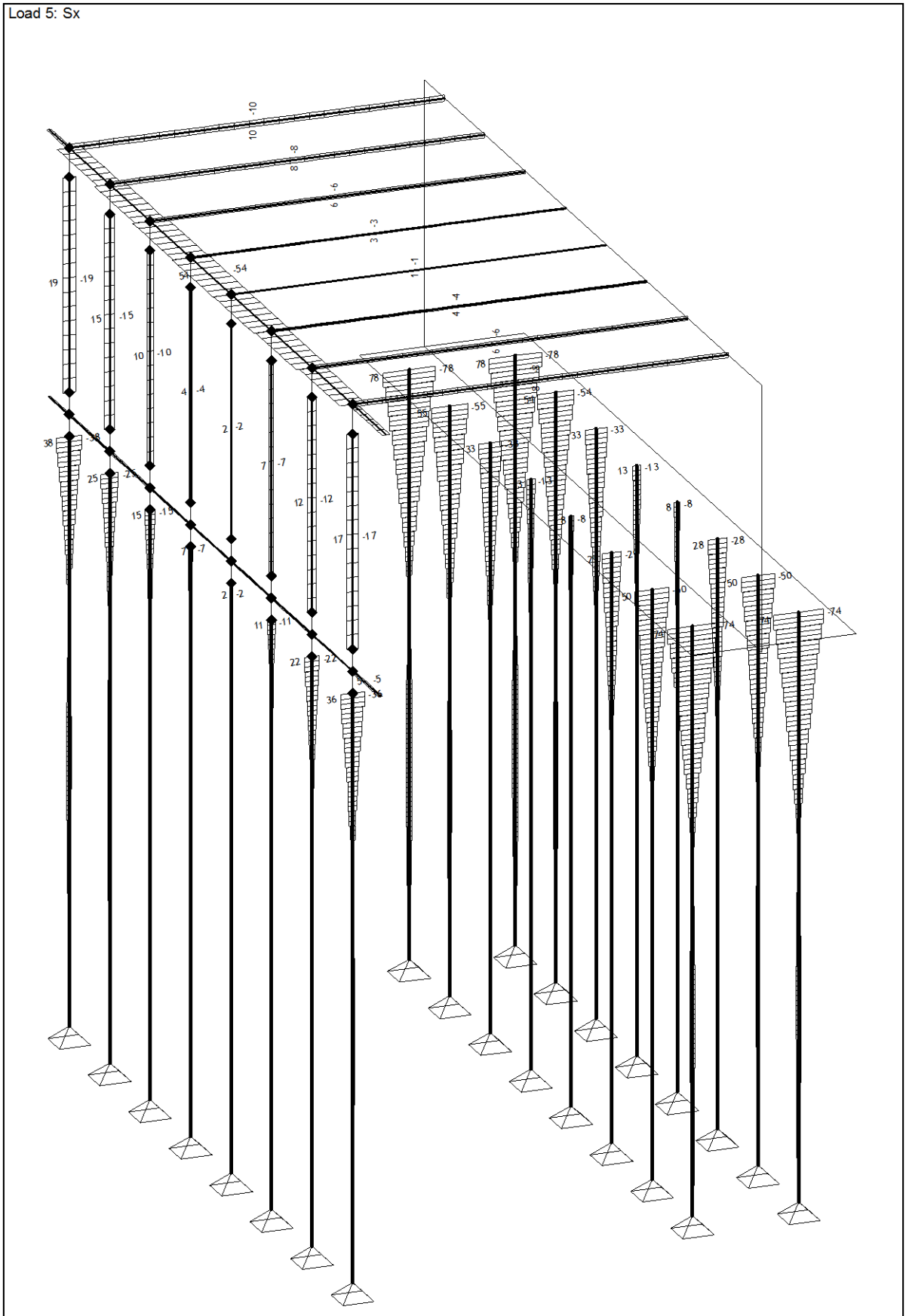
Isometric
Beam Results: max M2= 206 / min M2= -206 kNm

Load 5: Sx

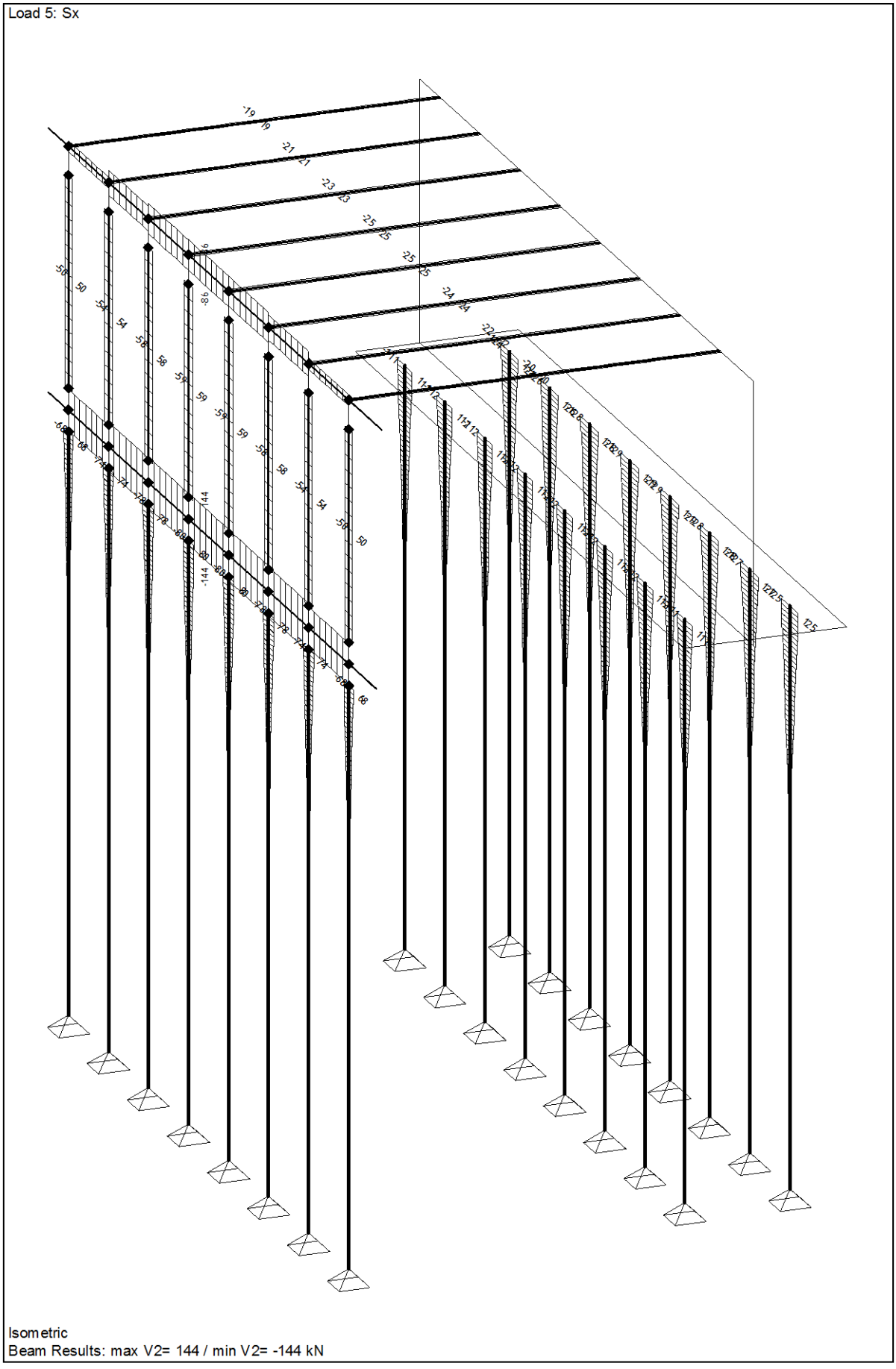


Isometric
Beam Results: max M1= 204 / min M1= -204 kNm

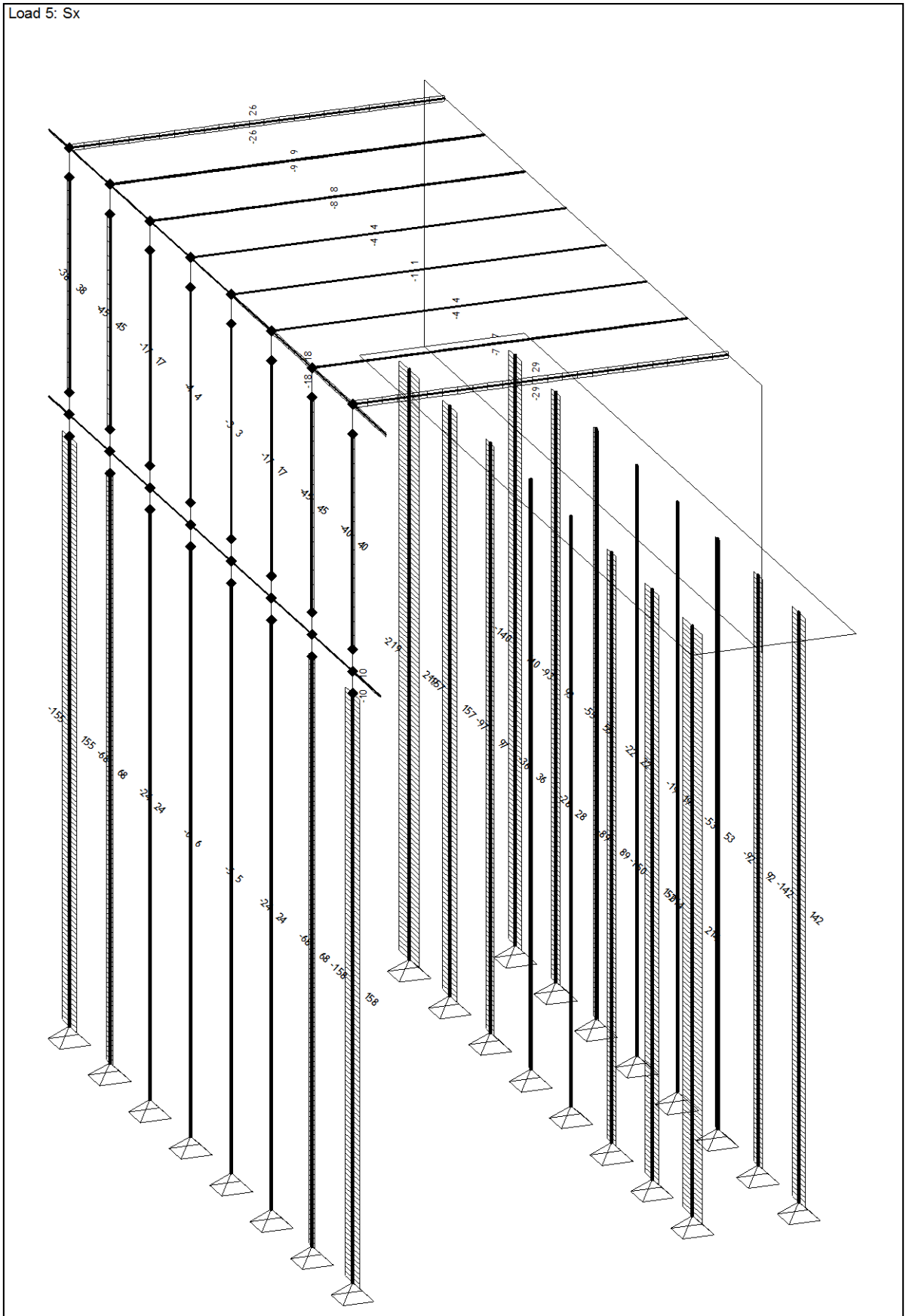
Load 5: Sx



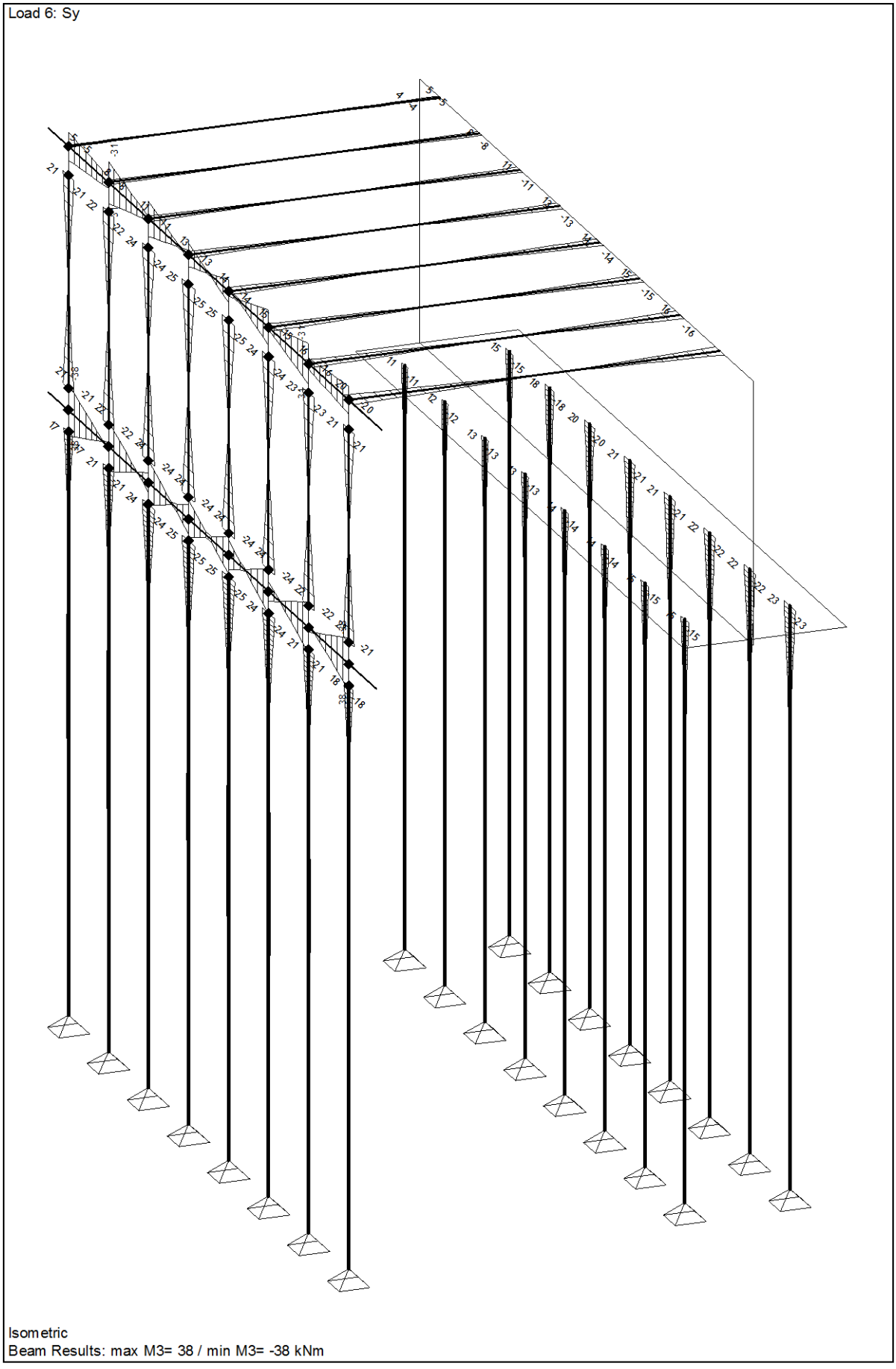
Isometric
Beam Results: max V3= 78 / min V3= -78 kN

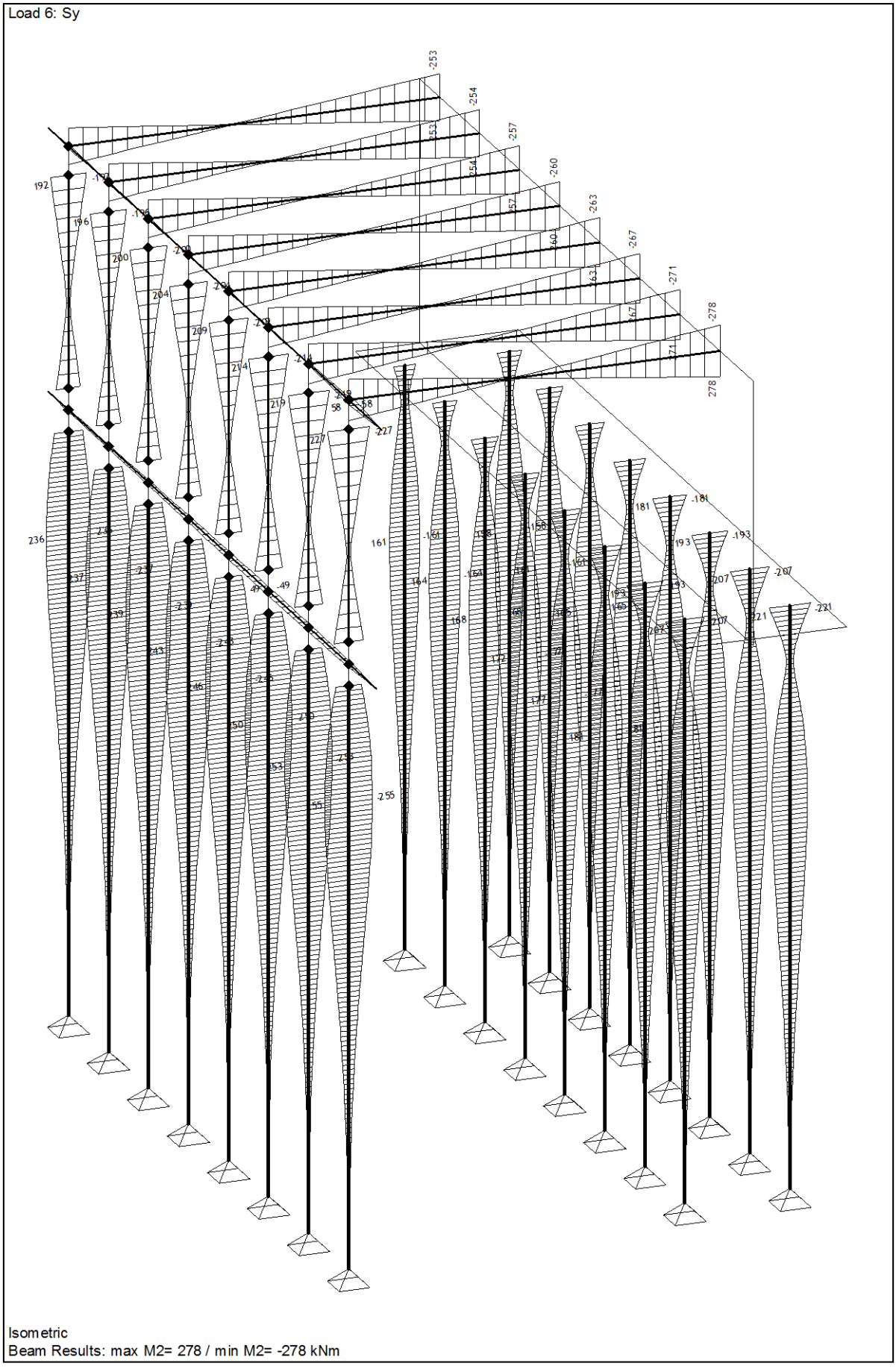

Load 5: Sx
Isometric
Beam Results: max V2= 144 / min V2= -144 kN

Load 5: Sx

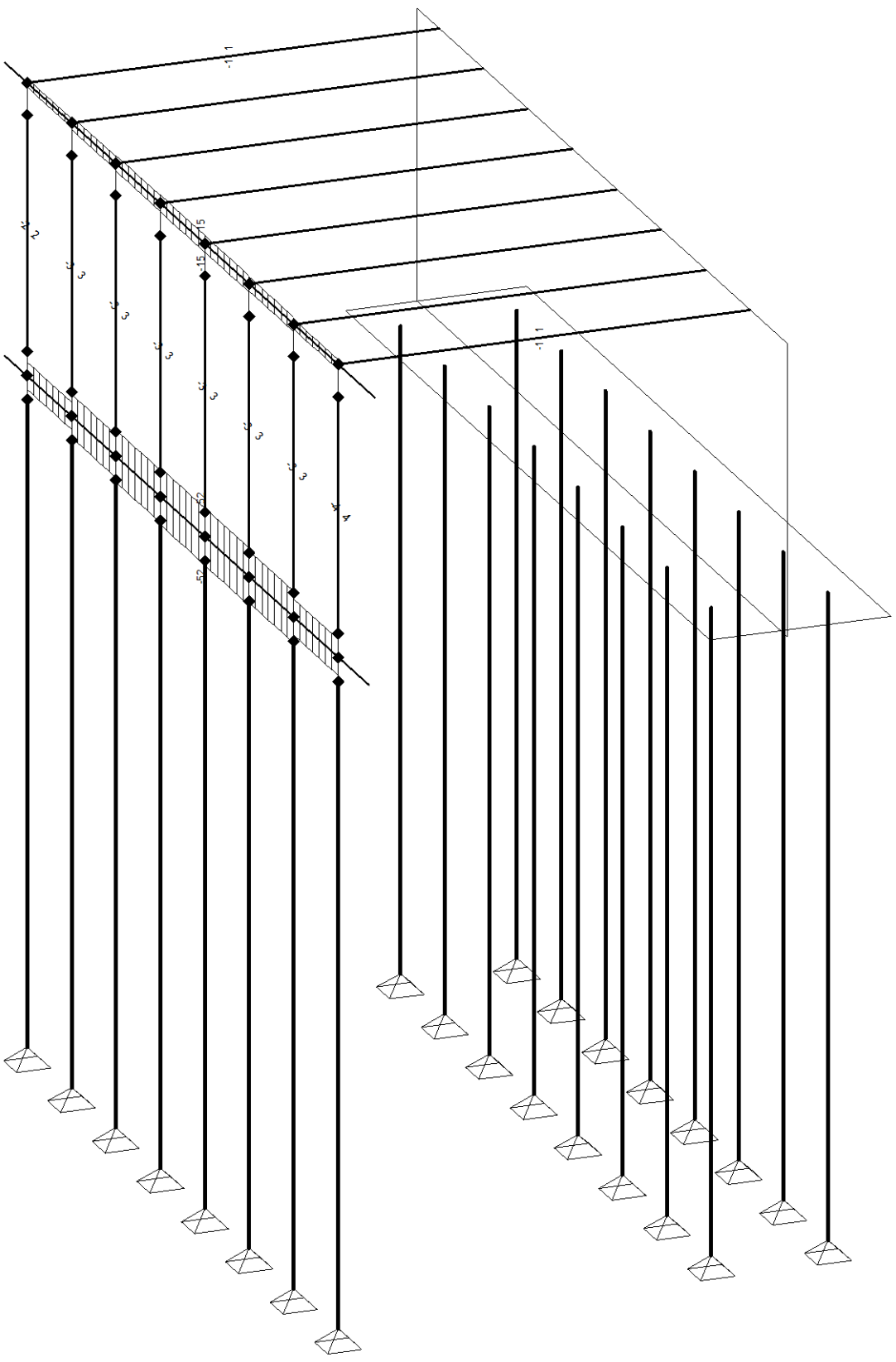


Isometric
Beam Results: max N1= 219 / min N1= -219 kN


Load 6: Sy
Isometric
Beam Results: max M3= 38 / min M3= -38 kNm

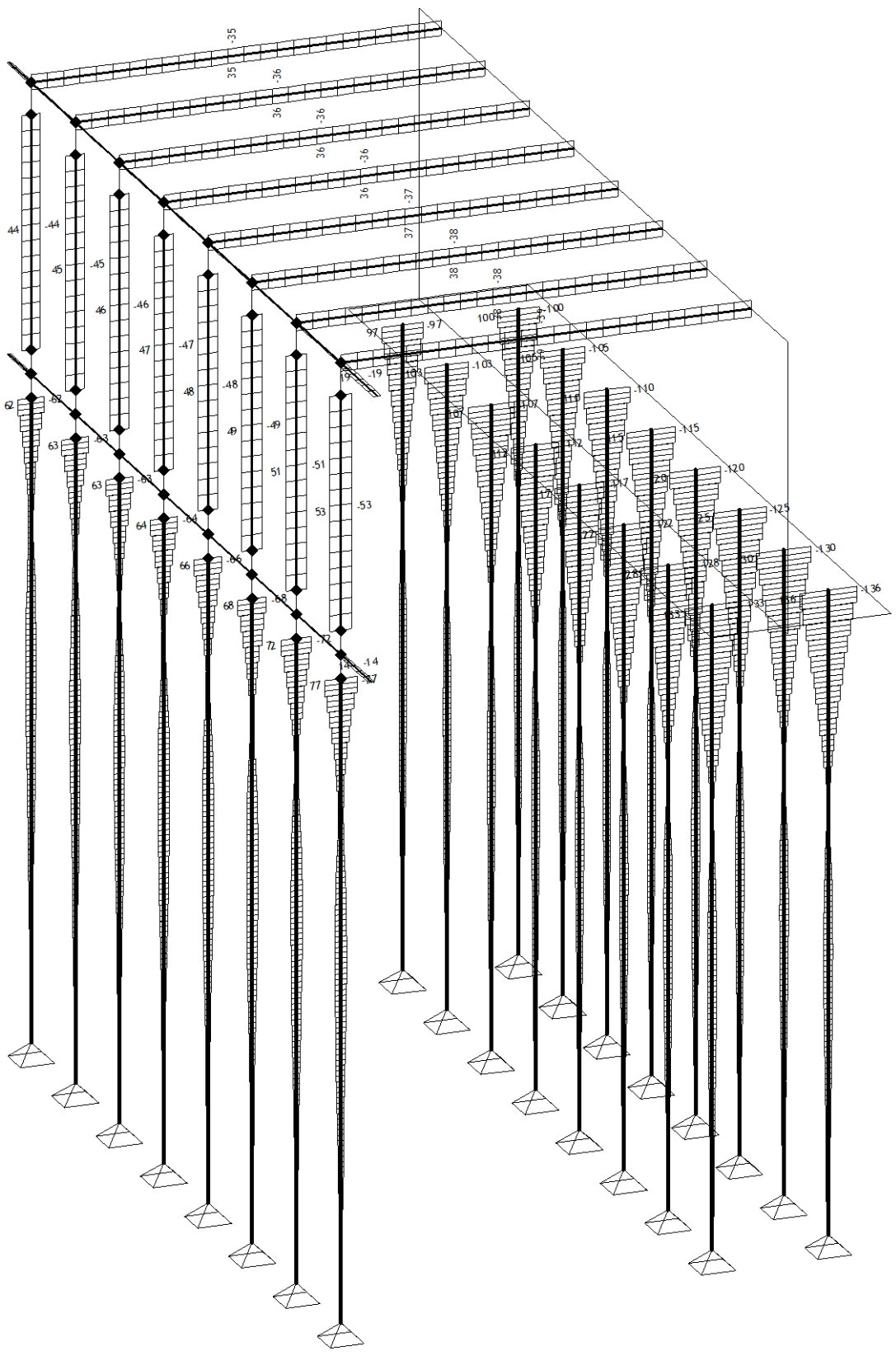

Load 6: Sy
Isometric
Beam Results: max M2= 278 / min M2= -278 kNm

Load 6: Sy



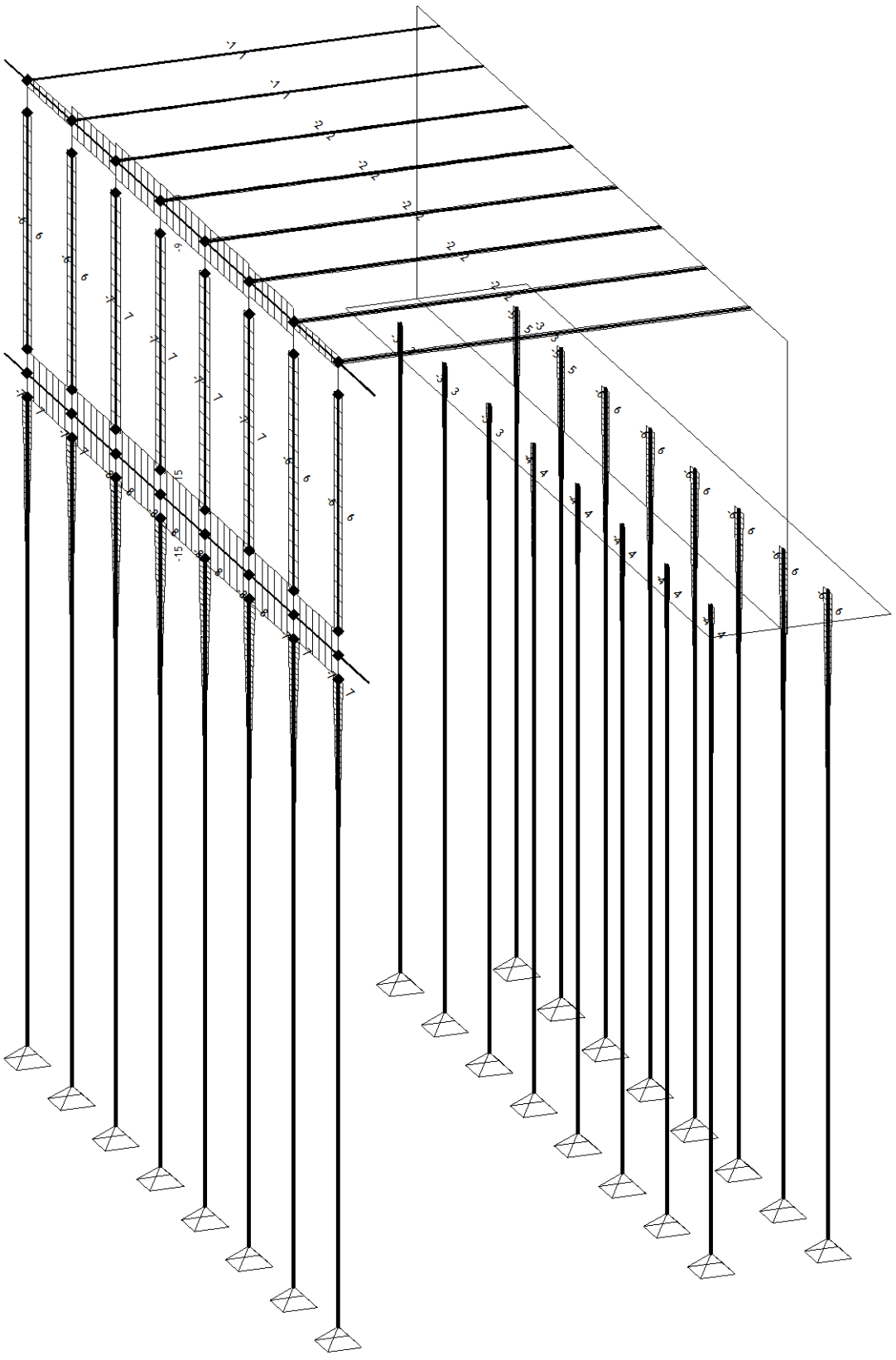
Isometric
Beam Results: max M1= 52 / min M1= -52 kNm

Load 6: Sy

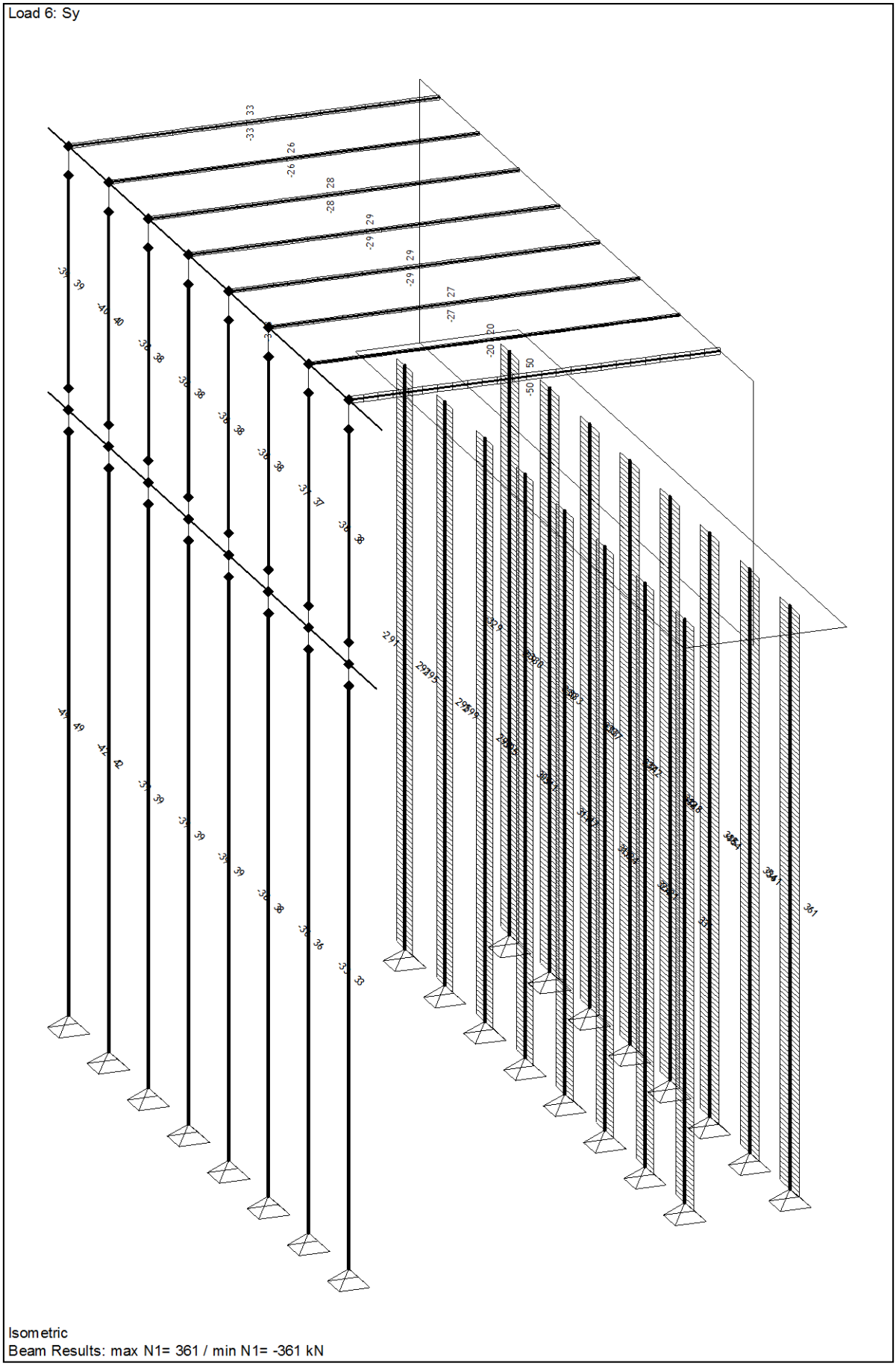


Isometric
Beam Results: max V3= 136 / min V3= -136 kN

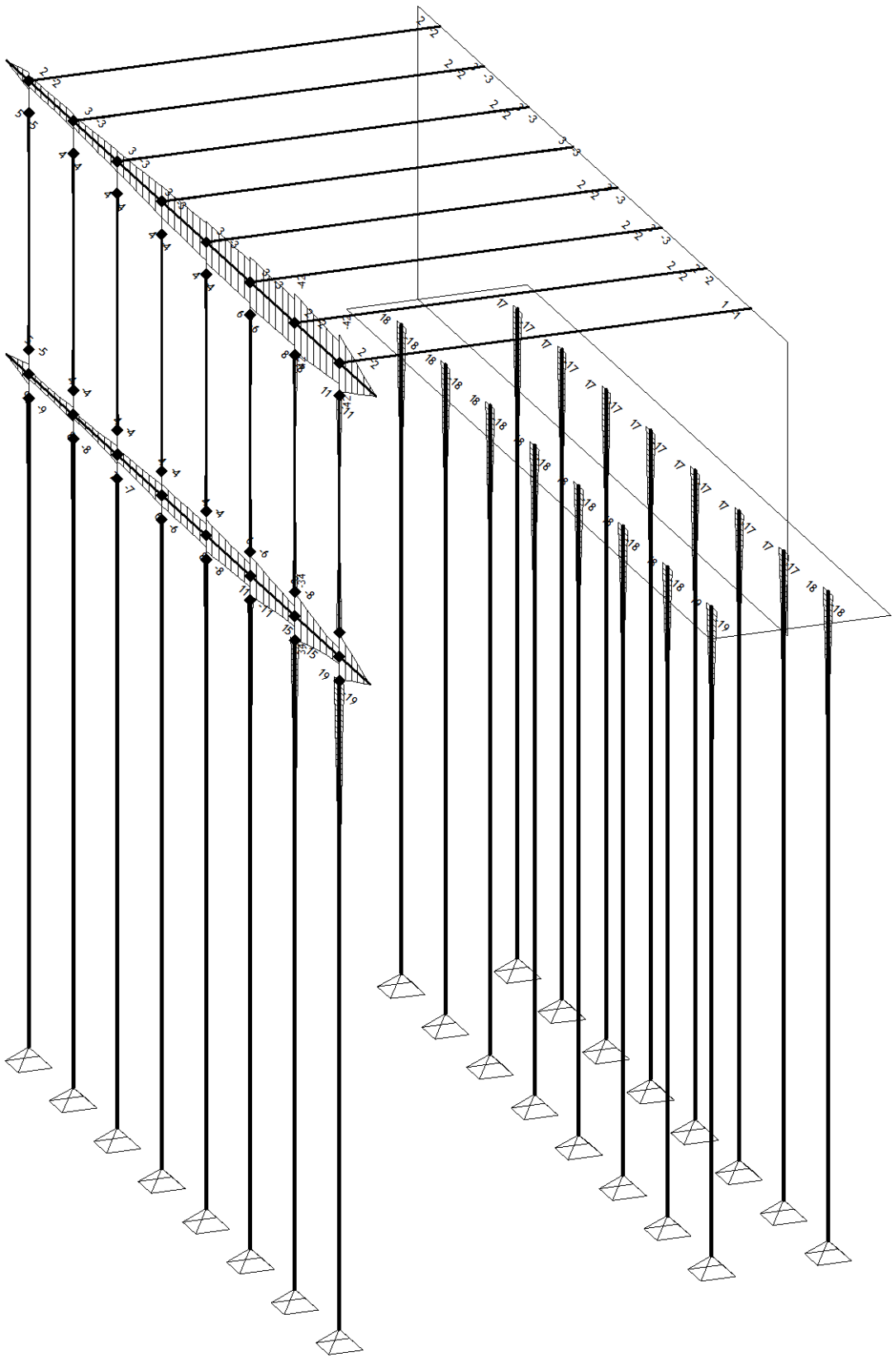
Load 6: Sy



Isometric
Beam Results: max V2= 16 / min V2= -16 kN

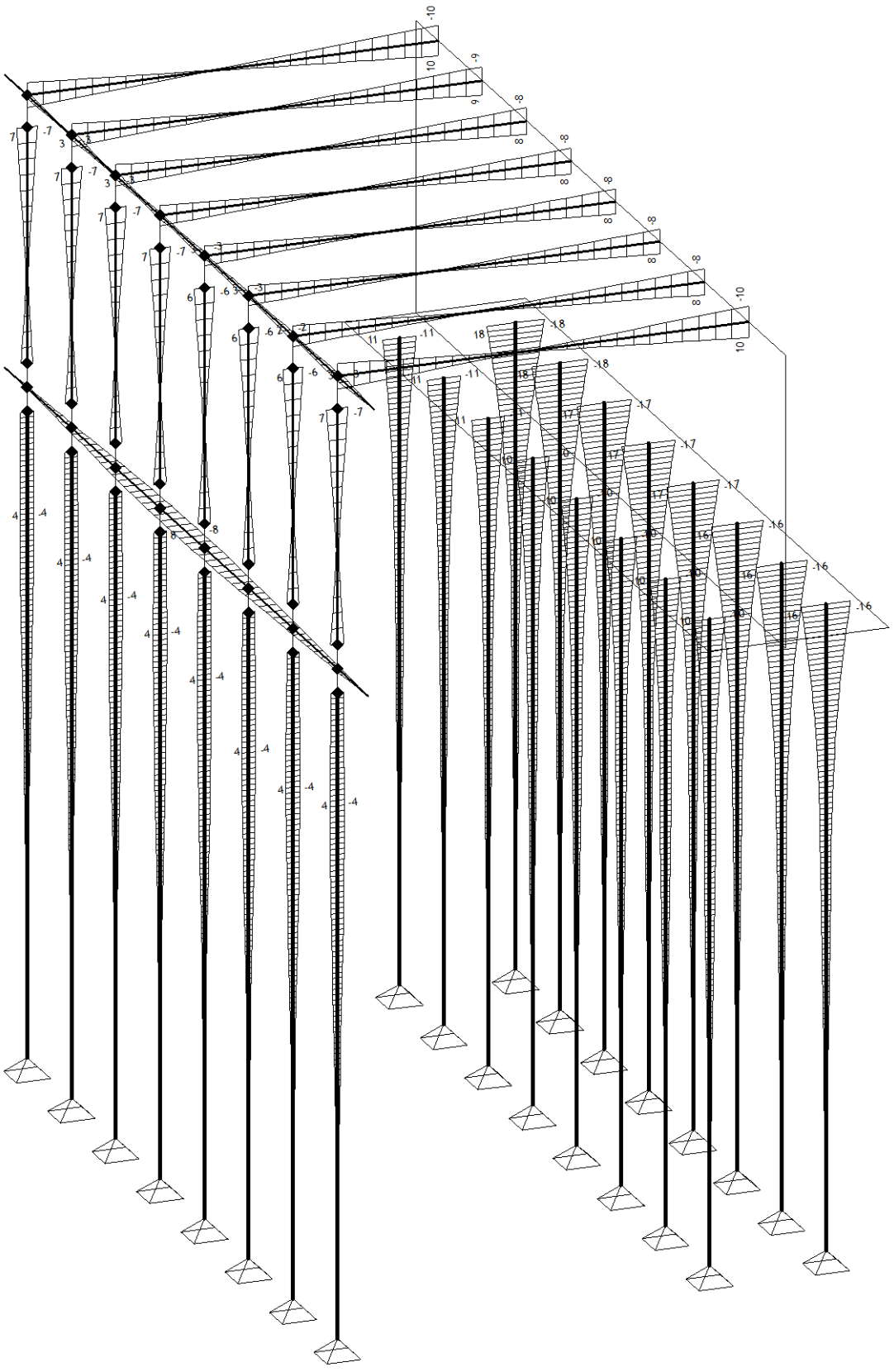

Load 6: Sy
Isometric
Beam Results: max N1= 361 / min N1= -361 kN

Load 7: Sz



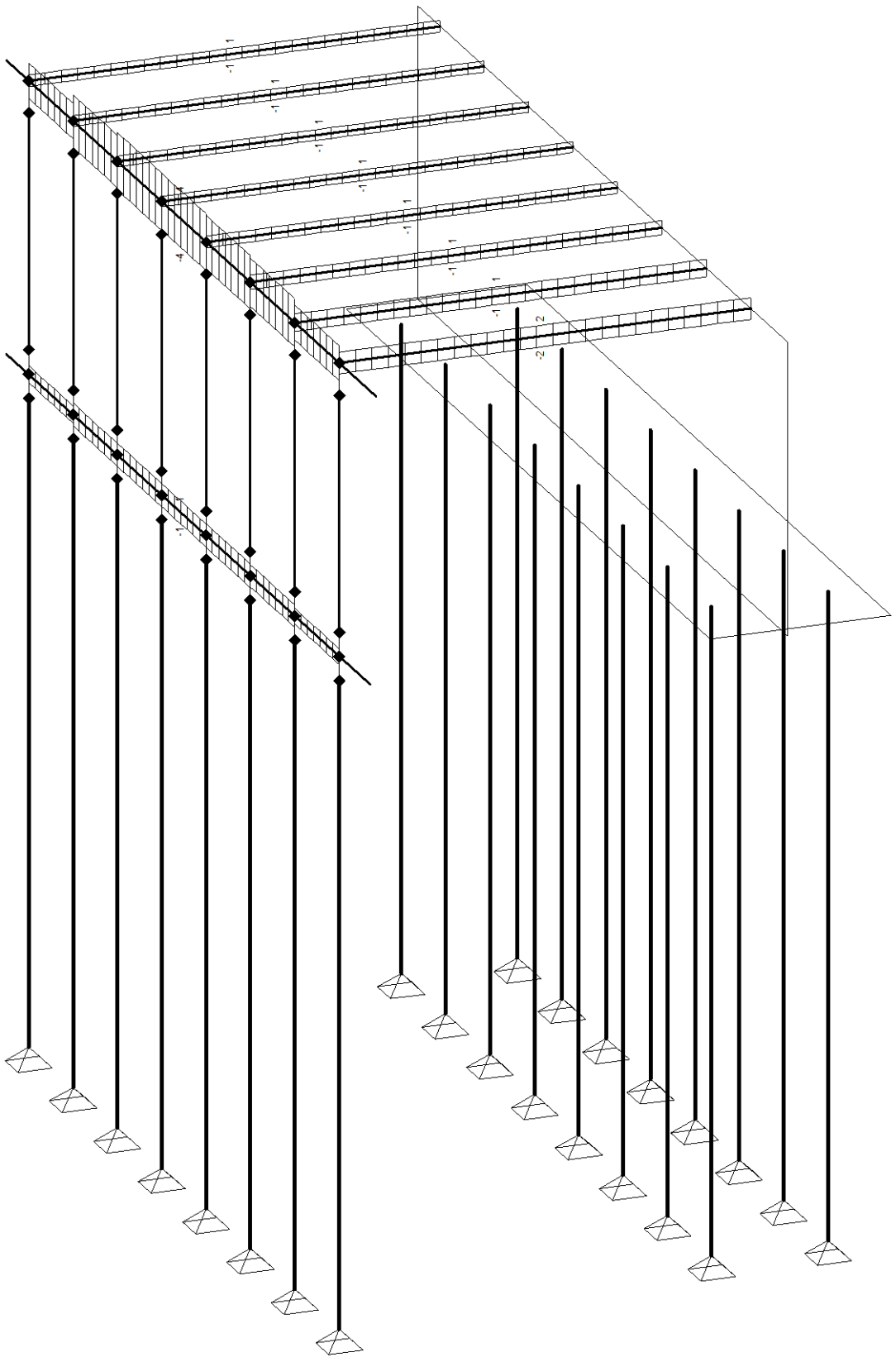
Isometric
Beam Results: max M3= 42 / min M3= -42 kNm

Load 7: Sz



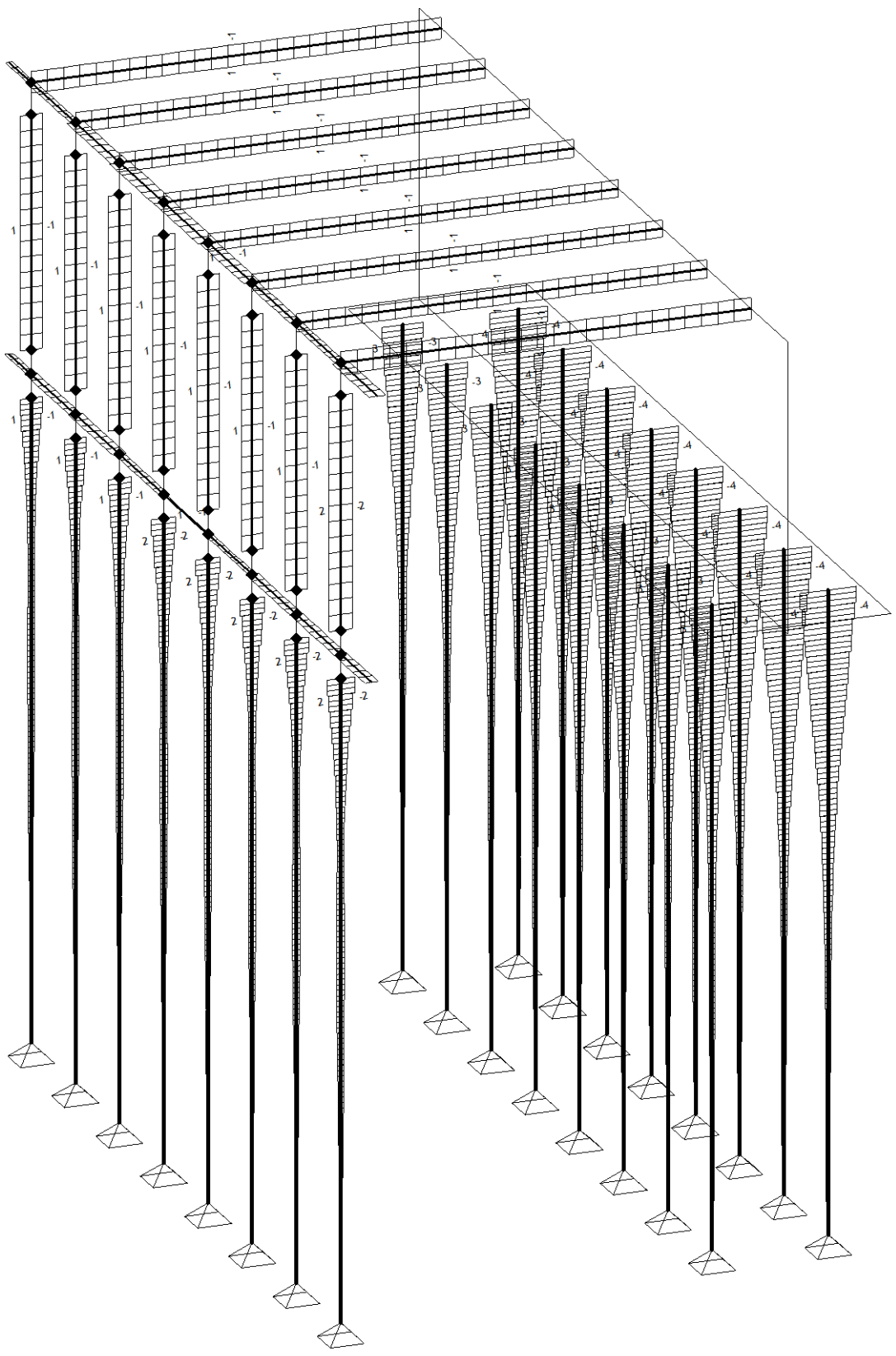
Isometric
Beam Results: max M2= 18 / min M2= -18 kNm

Load 7: Sz



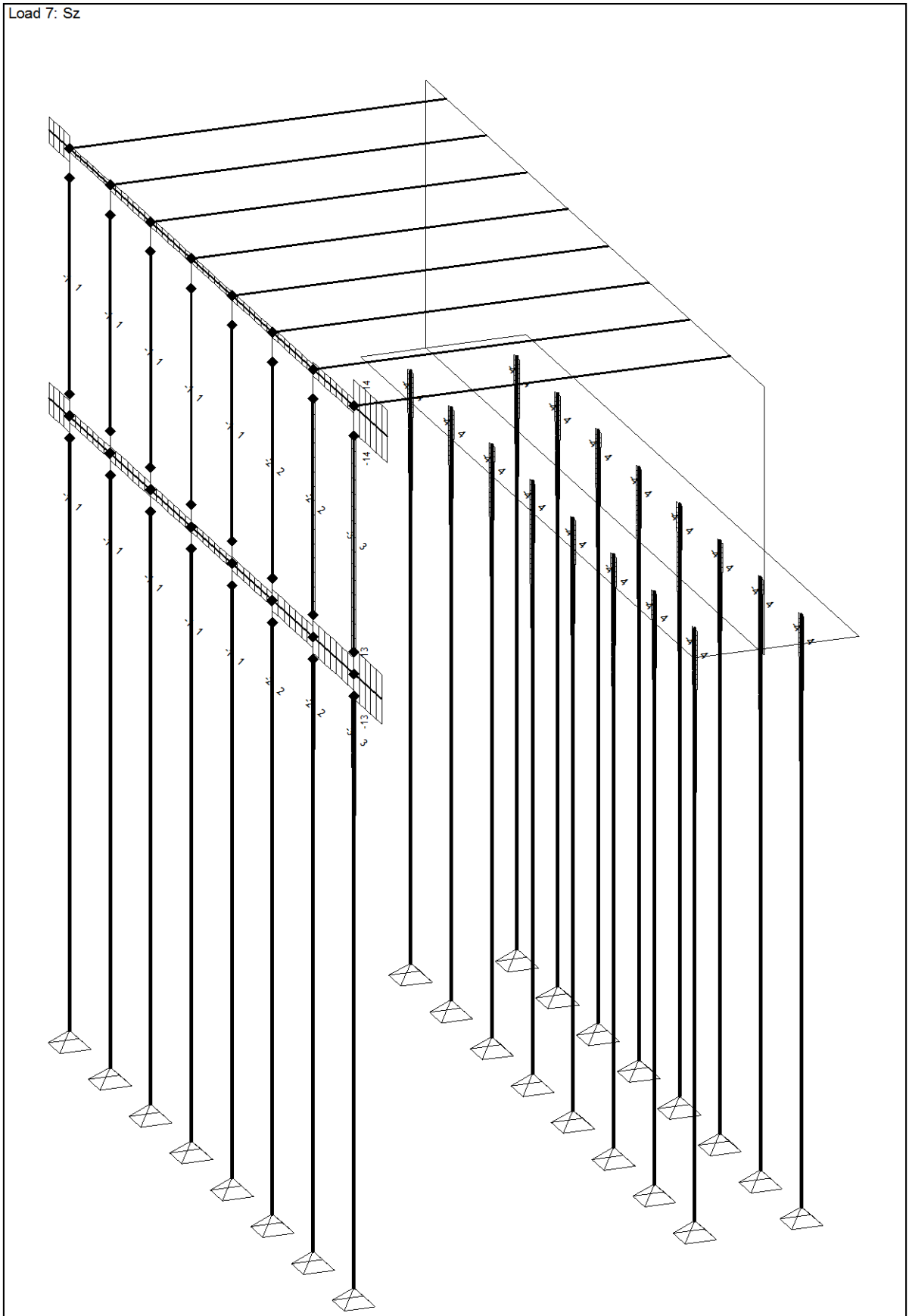
Isometric
Beam Results: max M1= 4 / min M1= -4 kNm

Load 7: Sz

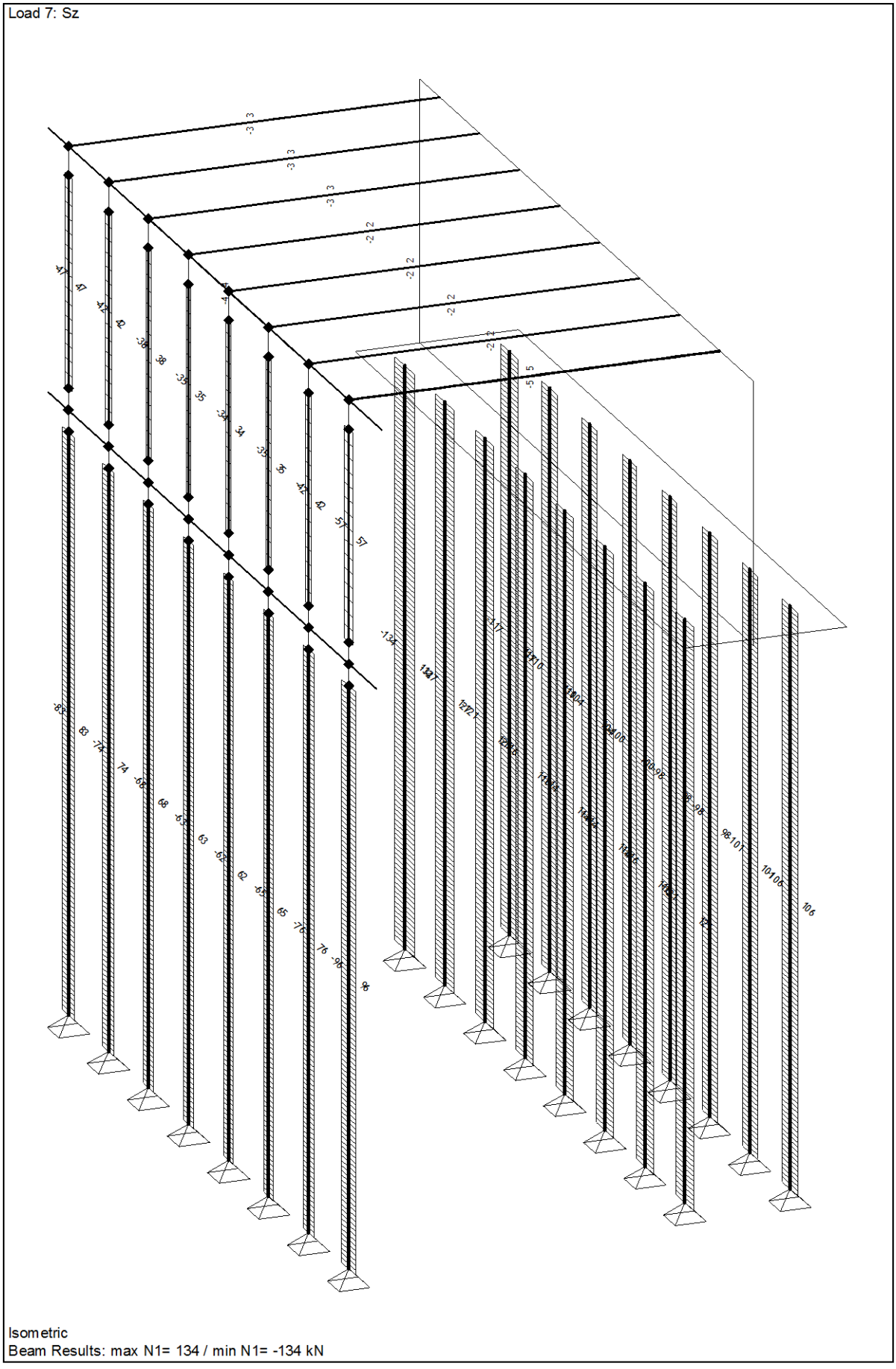


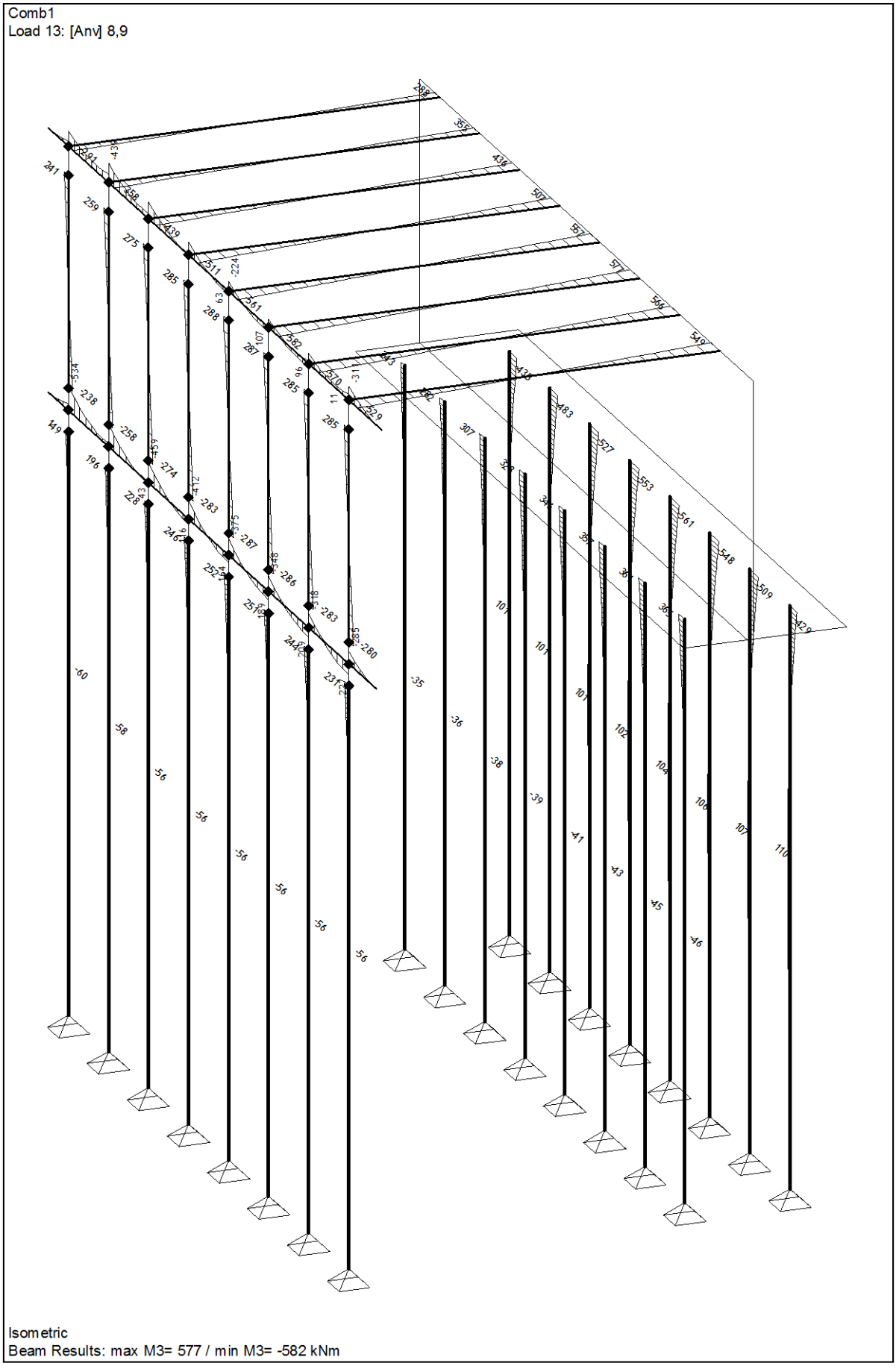
Isometric
Beam Results: max V3= 4 / min V3= -4 kN

Load 7: Sz

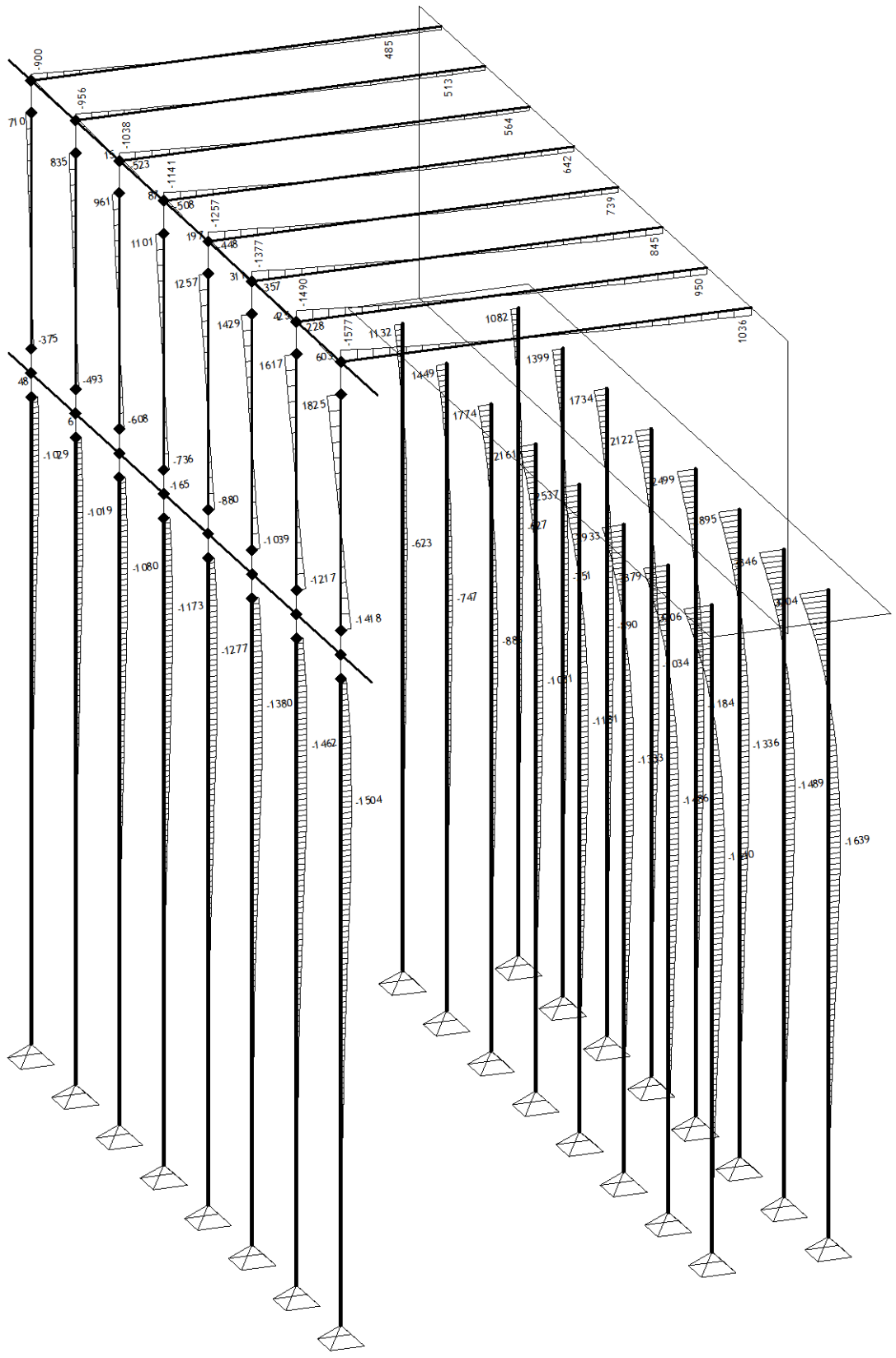


Isometric
Beam Results: max V2= 14 / min V2= -14 kN

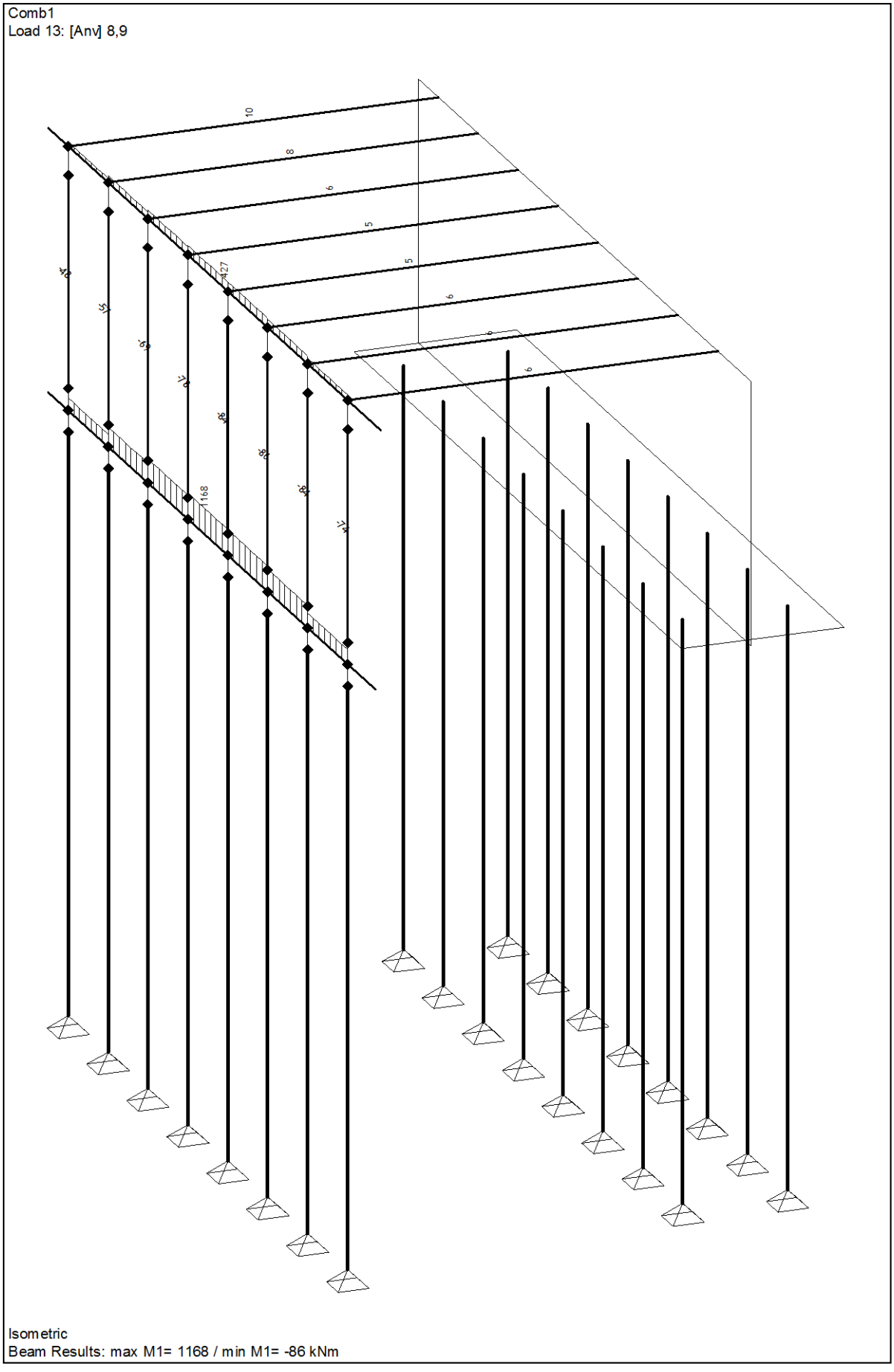

Load 7: Sz
Isometric
Beam Results: max N1= 134 / min N1= -134 kN

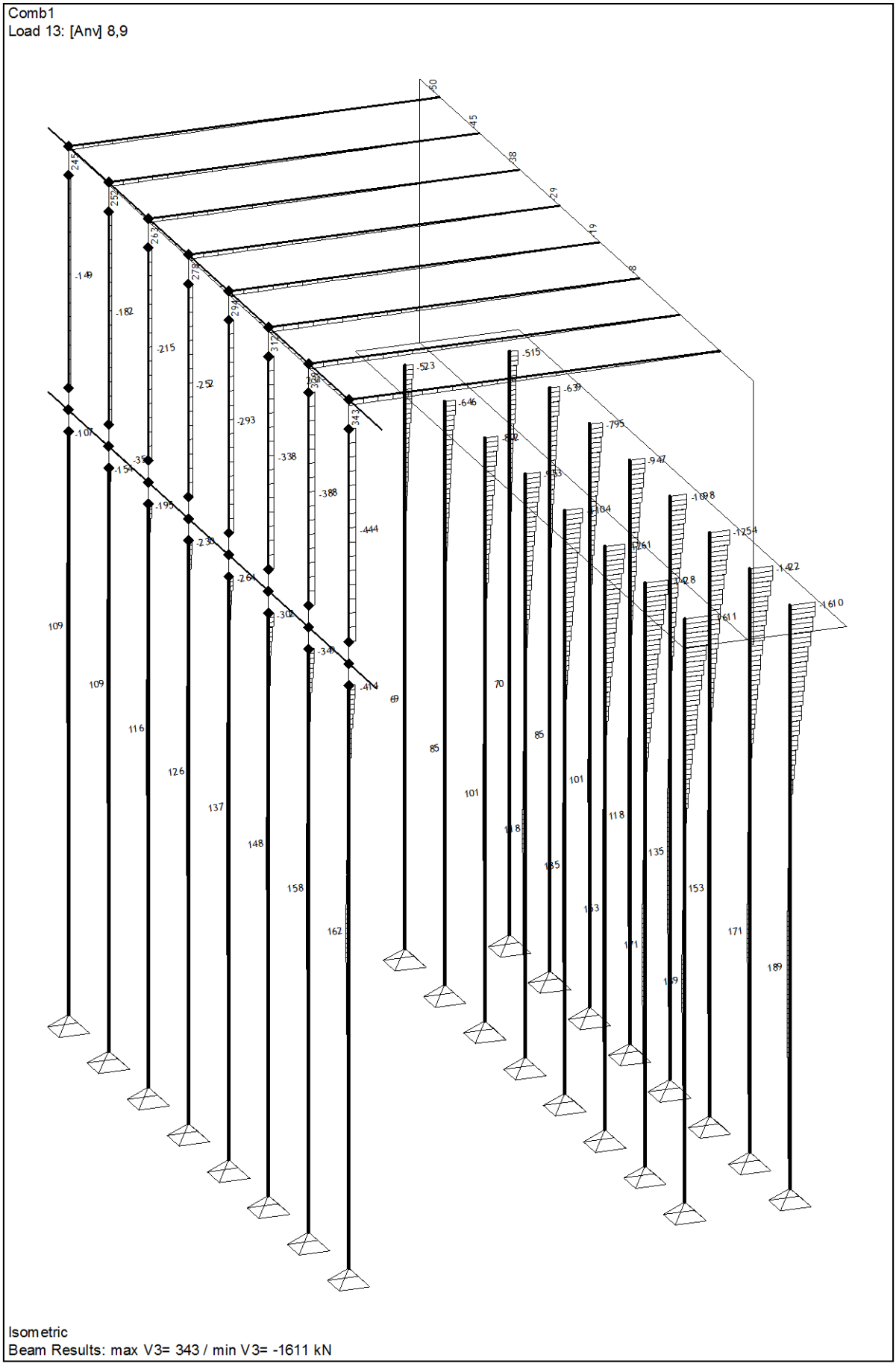

Comb1
Load 13: [Anv] 8,9
Isometric
Beam Results: max M3= 577 / min M3= -582 kNm

Comb1
Load 13: [Anv] 8,9

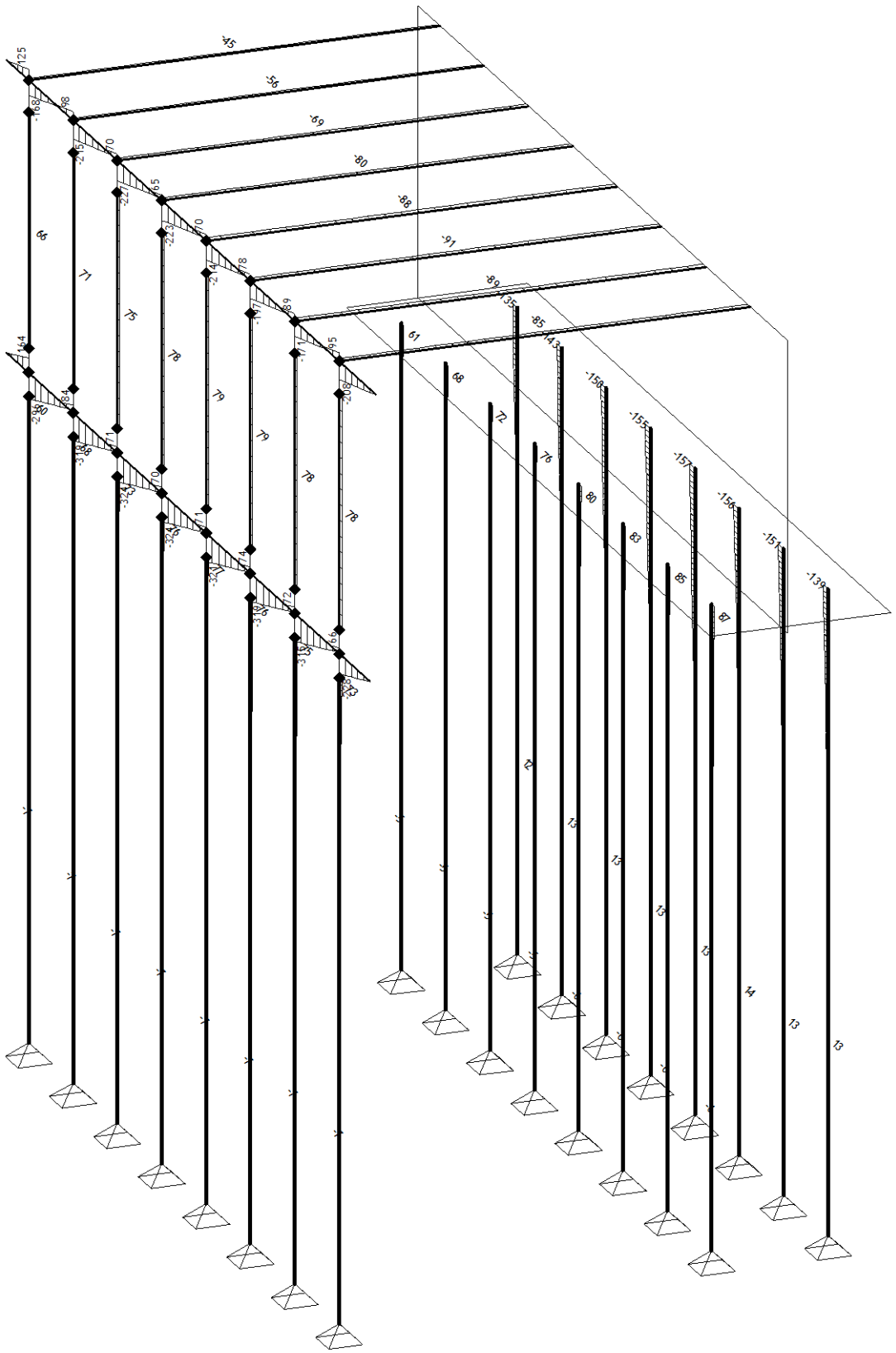


Isometric
Beam Results: max M2= 3906 / min M2= -1640 kNm

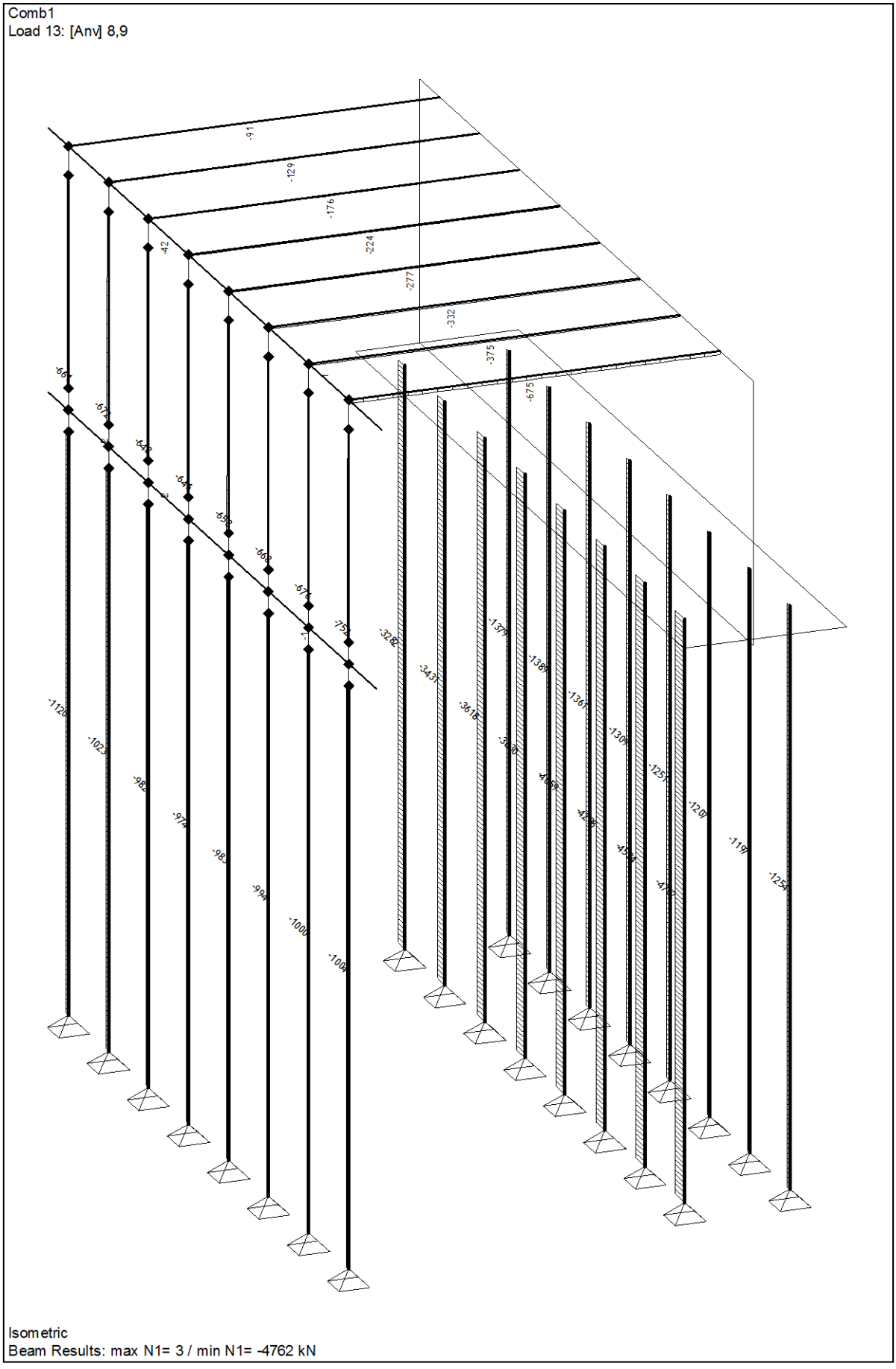

Comb1
Load 13: [Anv] 8,9
10
8
6
5
5
6
6
6
427
1168
Isometric
Beam Results: max M1= 1168 / min M1= -86 kNm

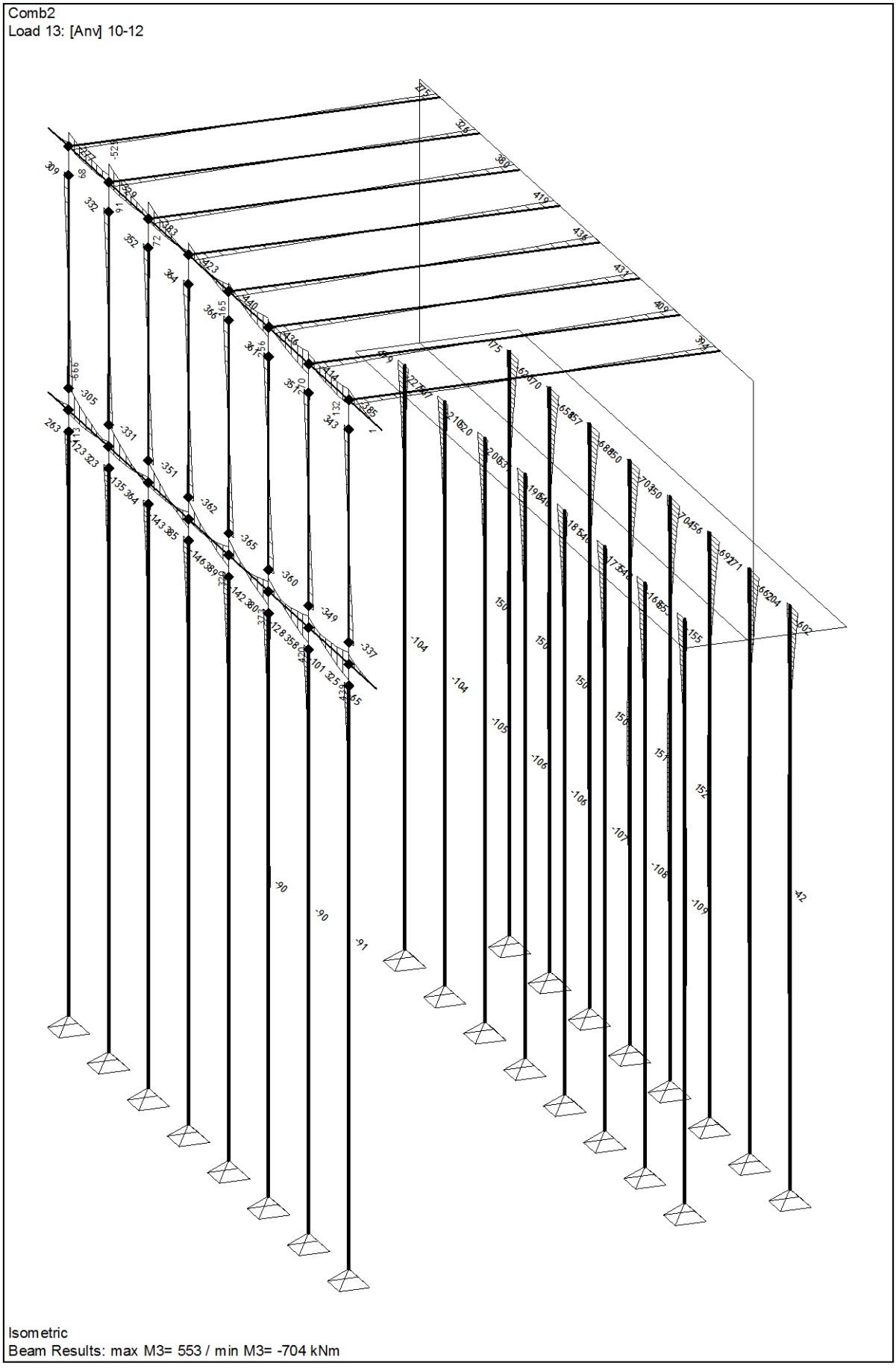

Comb1
Load 13: [Anv] 8,9
Isometric
Beam Results: max V3= 343 / min V3= -1611 kN

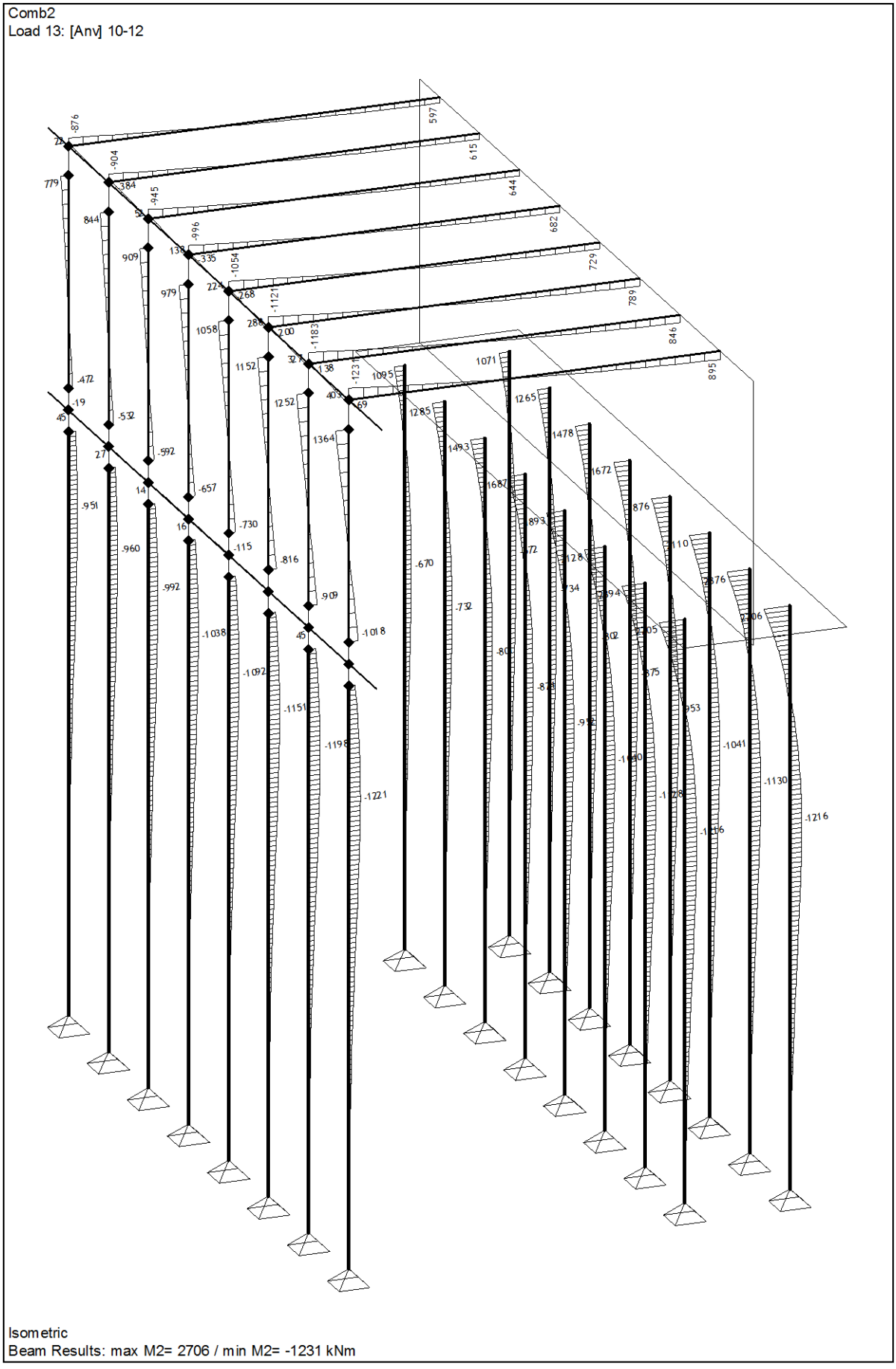
Comb1
Load 13: [Anv] 8,9



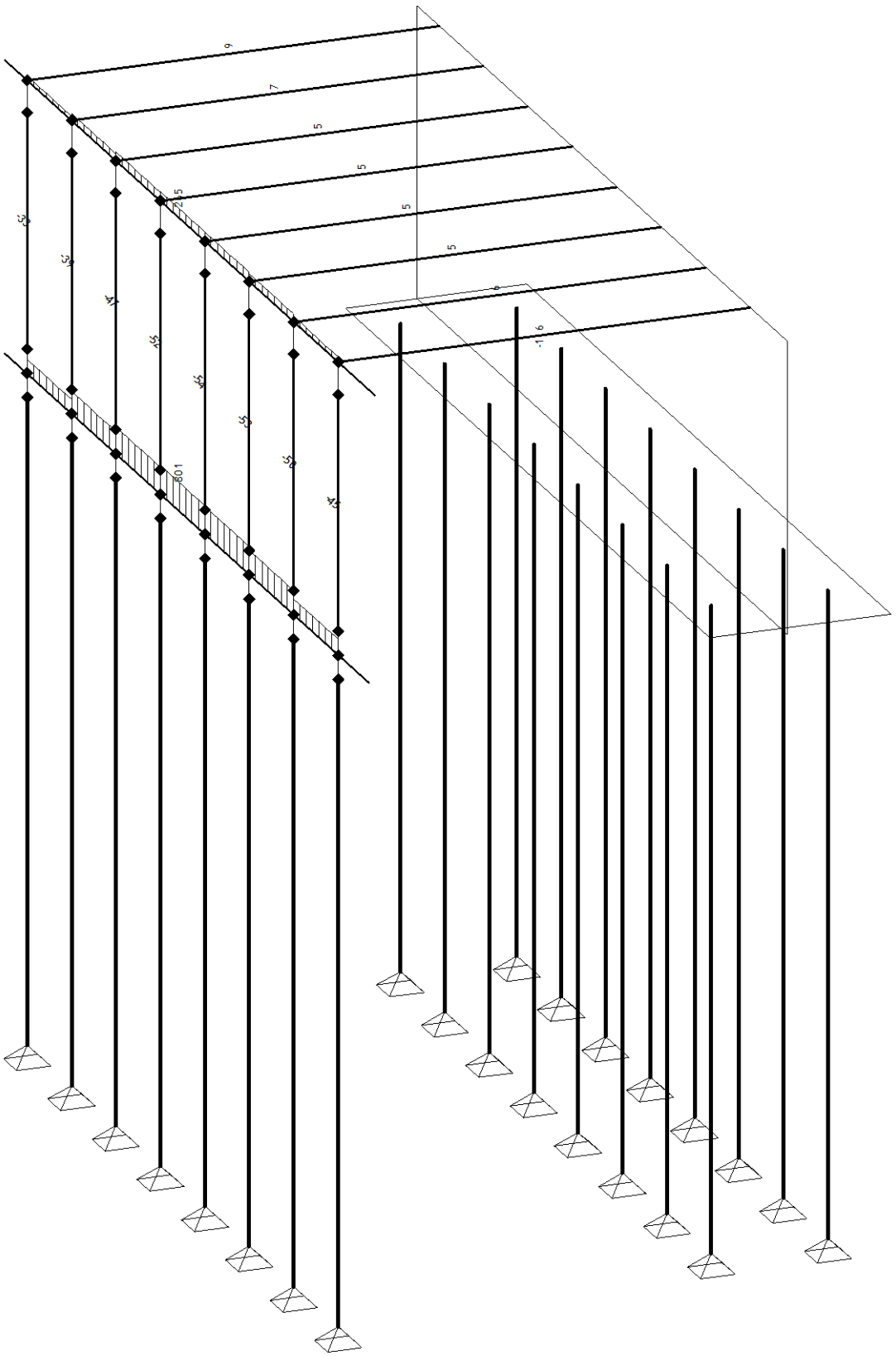
Isometric
Beam Results: max V2= 164 / min V2= -324 kN


Comb1
Load 13: [Anv] 8,9
Isometric
Beam Results: max N1= 3 / min N1= -4762 kN

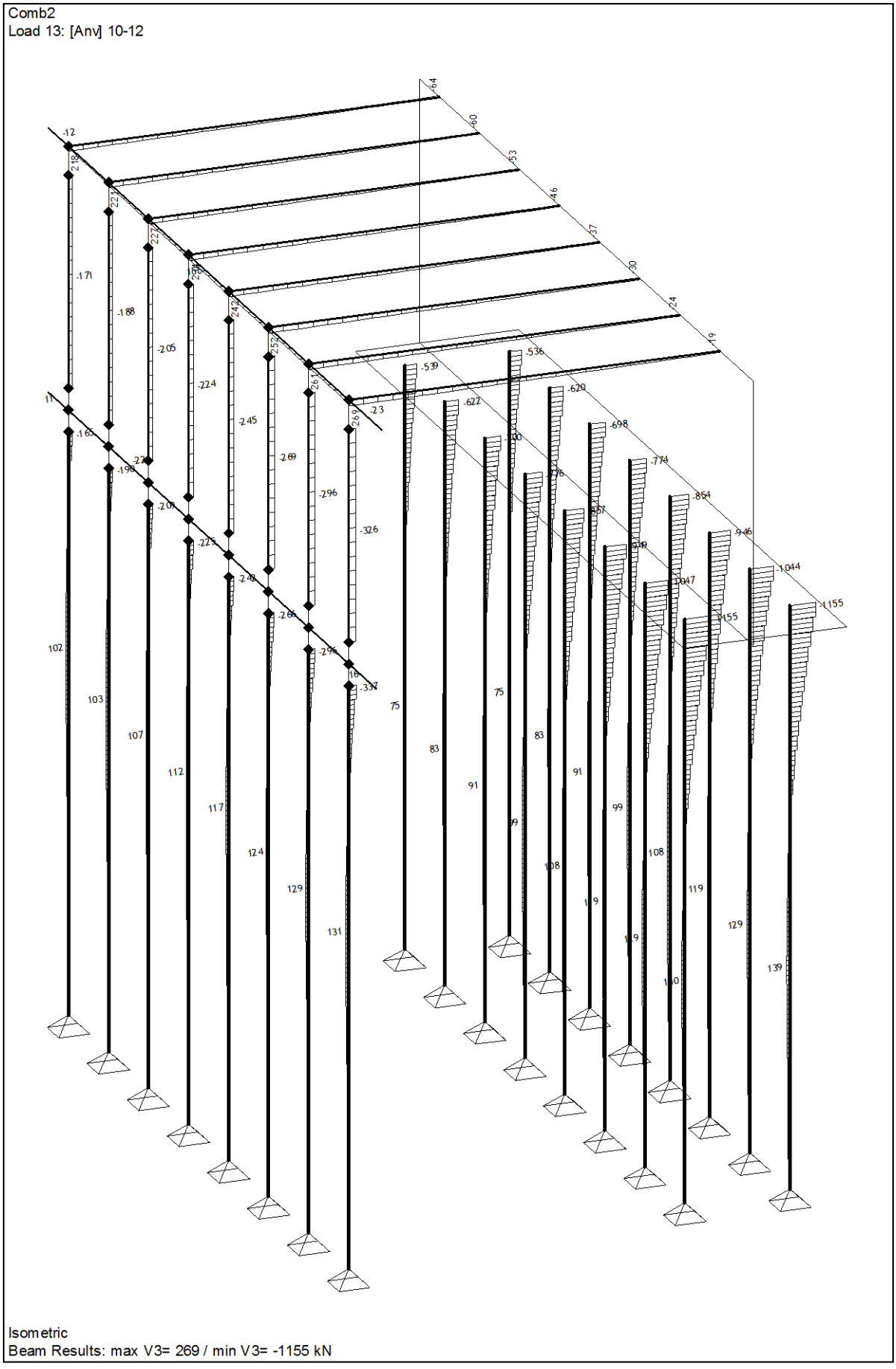

Comb2
Load 13: [Anv] 10-12
Isometric
Beam Results: max M3= 553 / min M3= -704 kNm

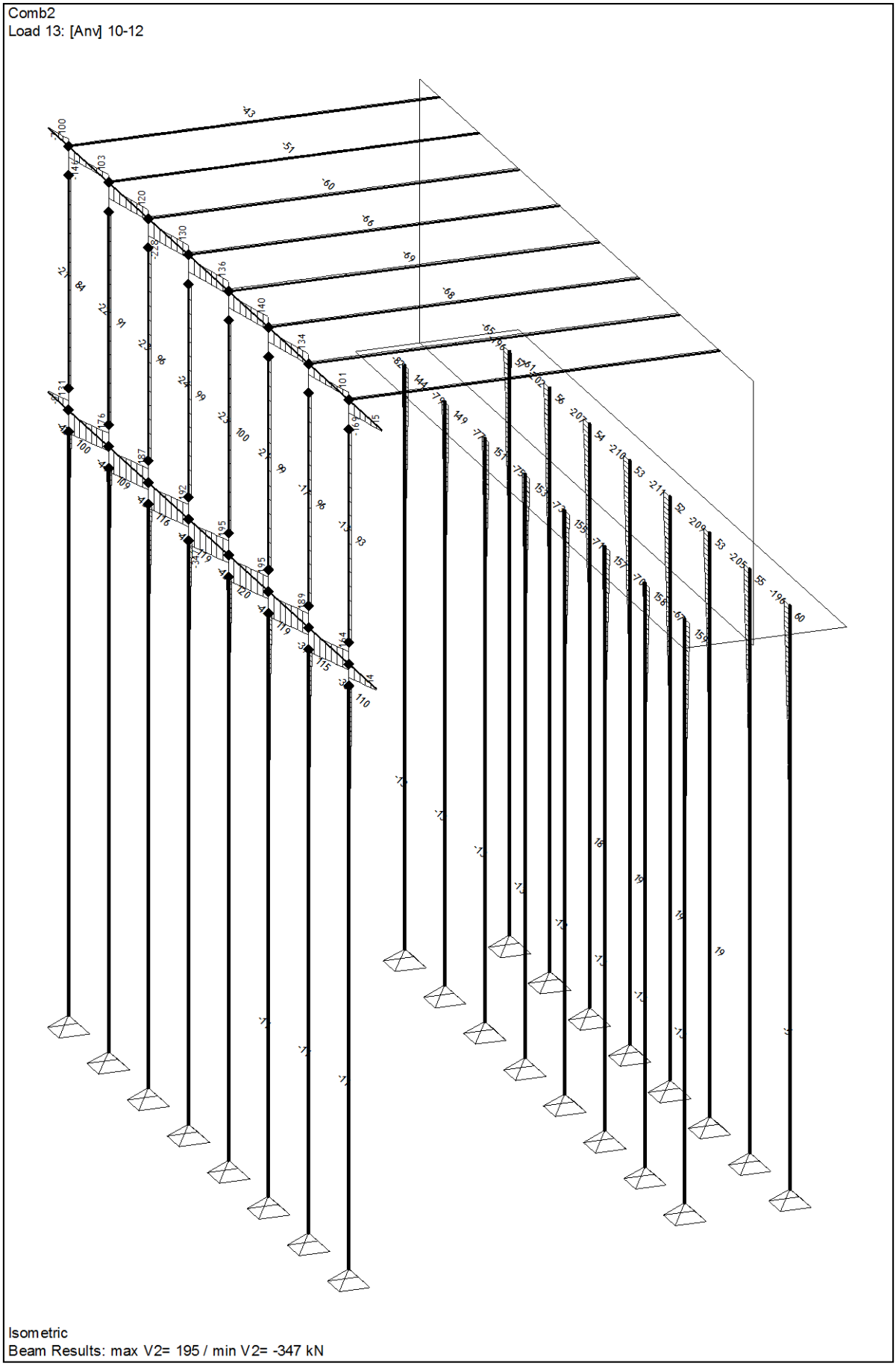

Comb2
Load 13: [Anv] 10-12
Isometric
Beam Results: max M2= 2706 / min M2= -1231 kNm

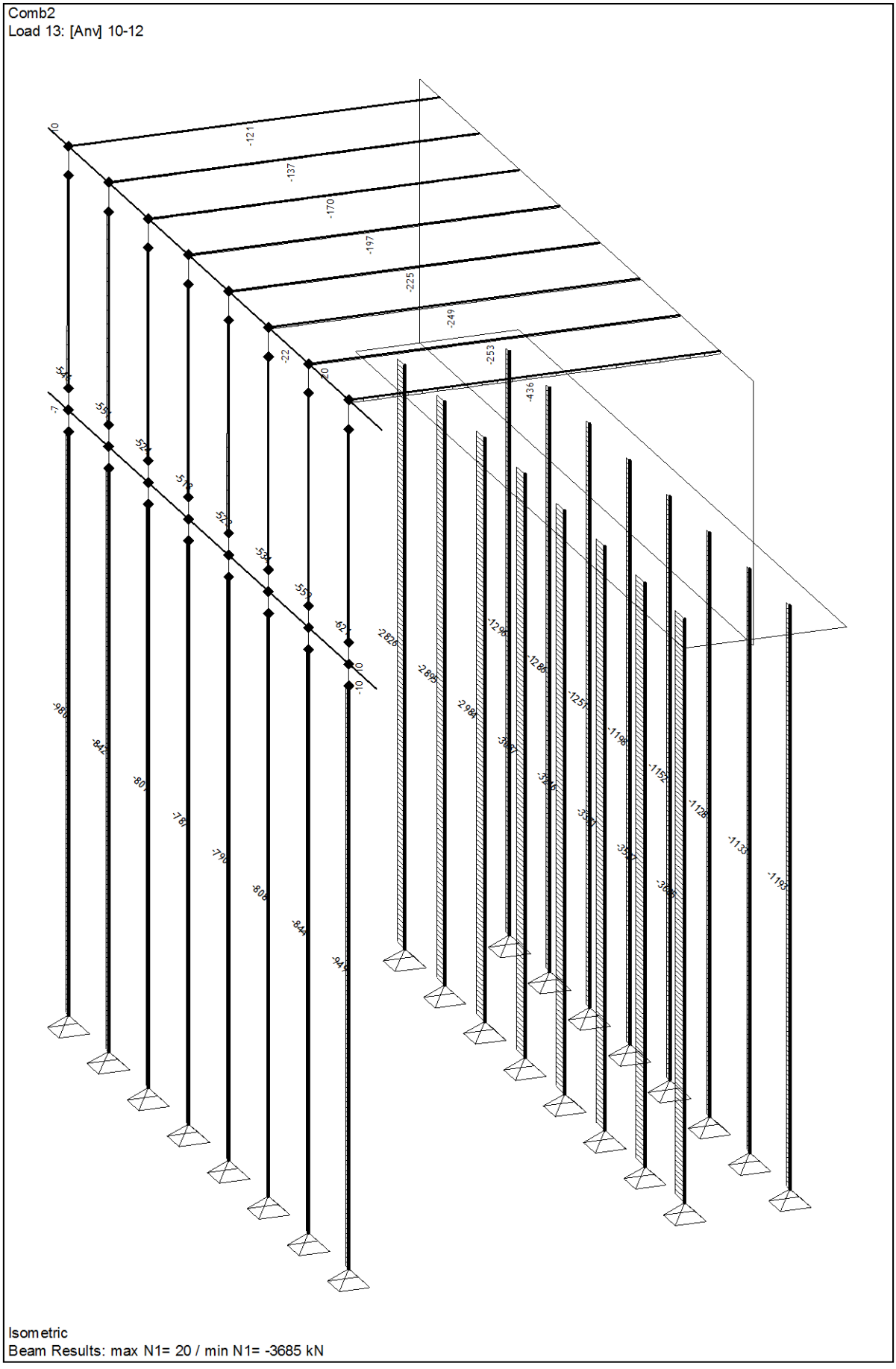
Comb2
Load 13: [Anv] 10-12



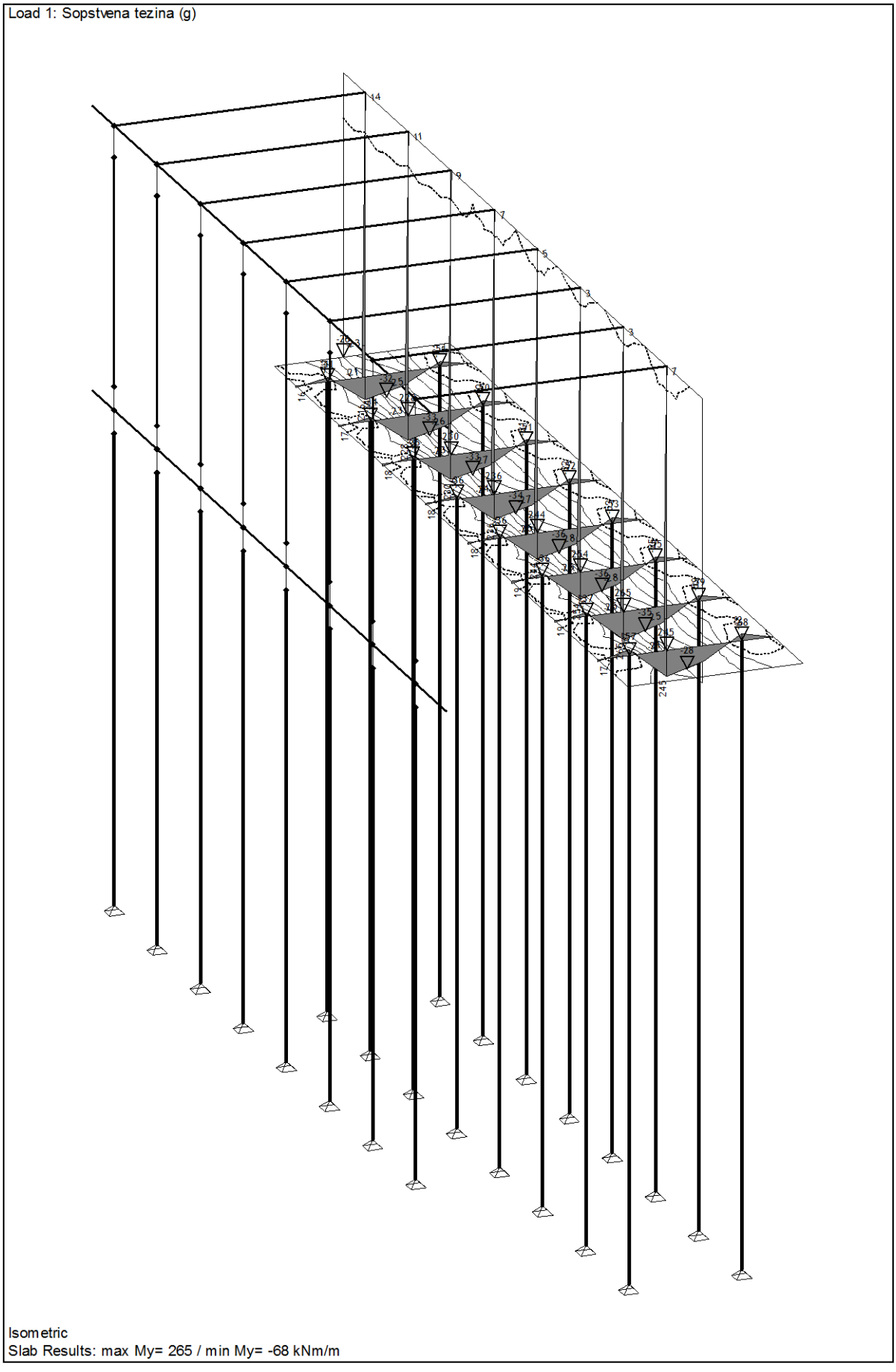
Isometric
Beam Results: max M1= 801 / min M1= -54 kNm


Comb2
Load 13: [Anv] 10-12
Isometric
Beam Results: max V3= 269 / min V3= -1155 kN

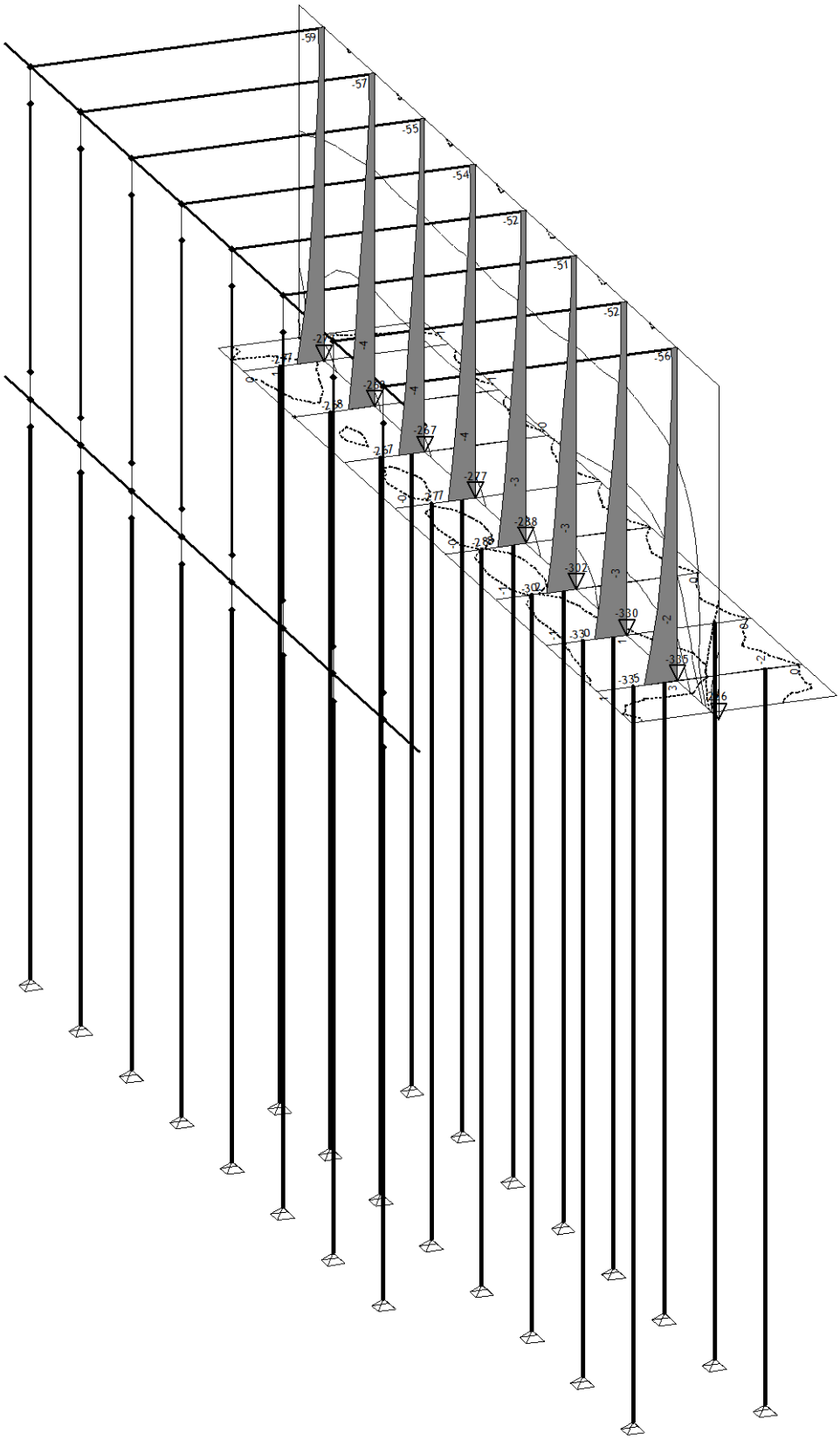

Comb2
Load 13: [Anv] 10-12
Isometric
Beam Results: max V2= 195 / min V2= -347 kN


Comb2
Load 13: [Anv] 10-12
Isometric
Beam Results: max N1= 20 / min N1= -3685 kN

6.2. Излаз / Exit

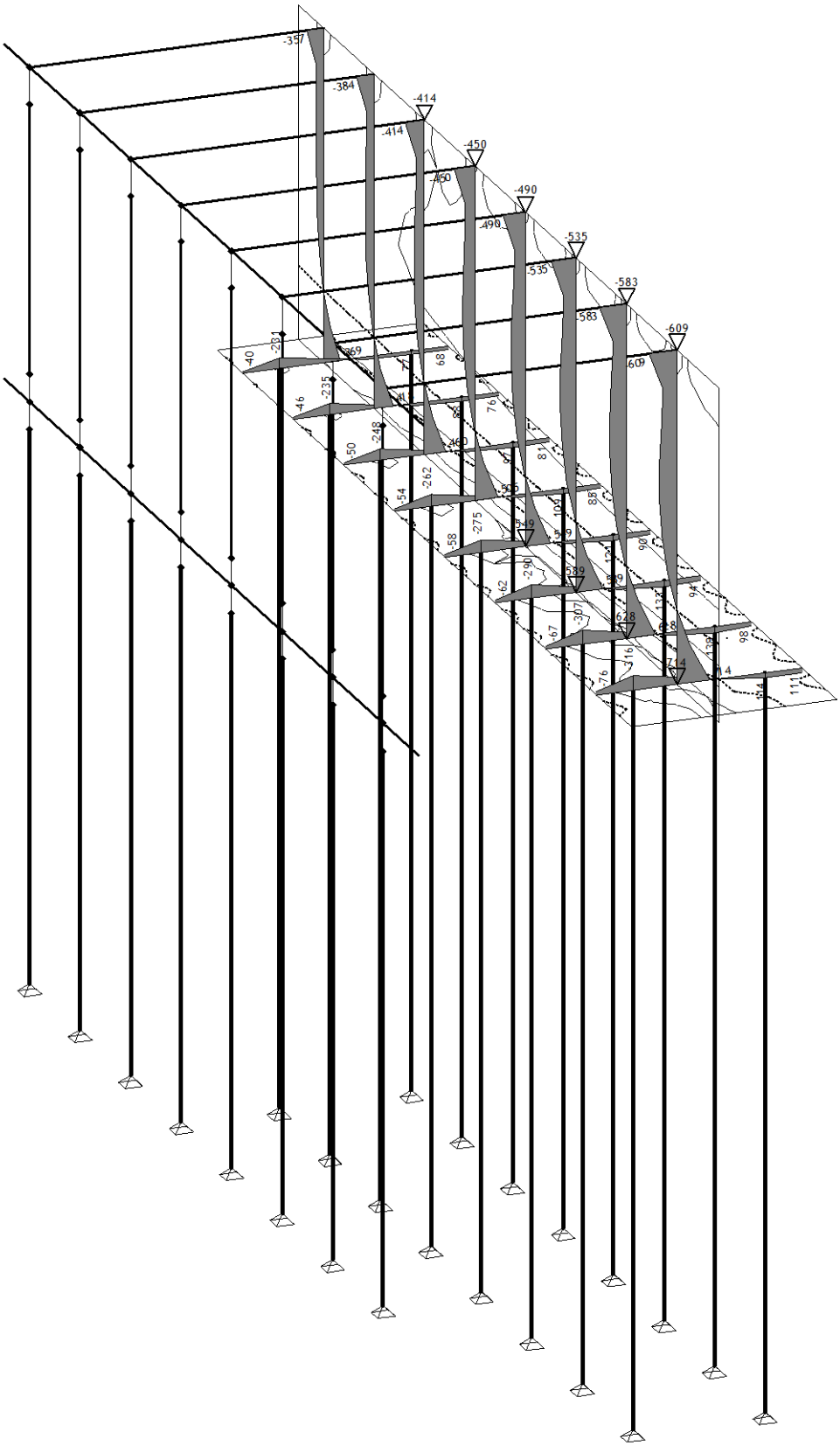


Load 1: Sopstvena tezina (g)



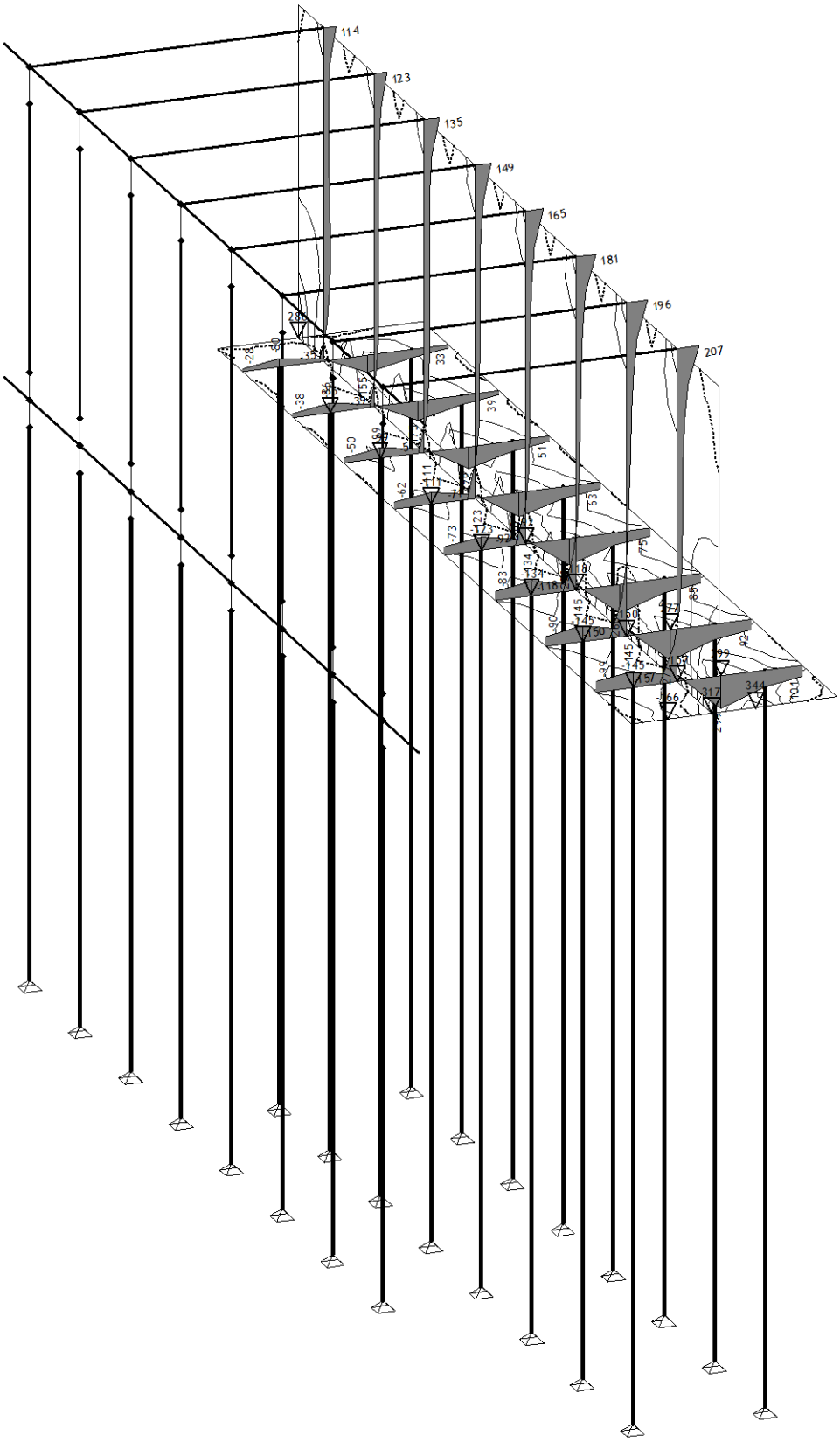
Isometric
Slab Results: max Ny= 226 / min Ny= -335 kN/m

Load 2: Pritisak tla



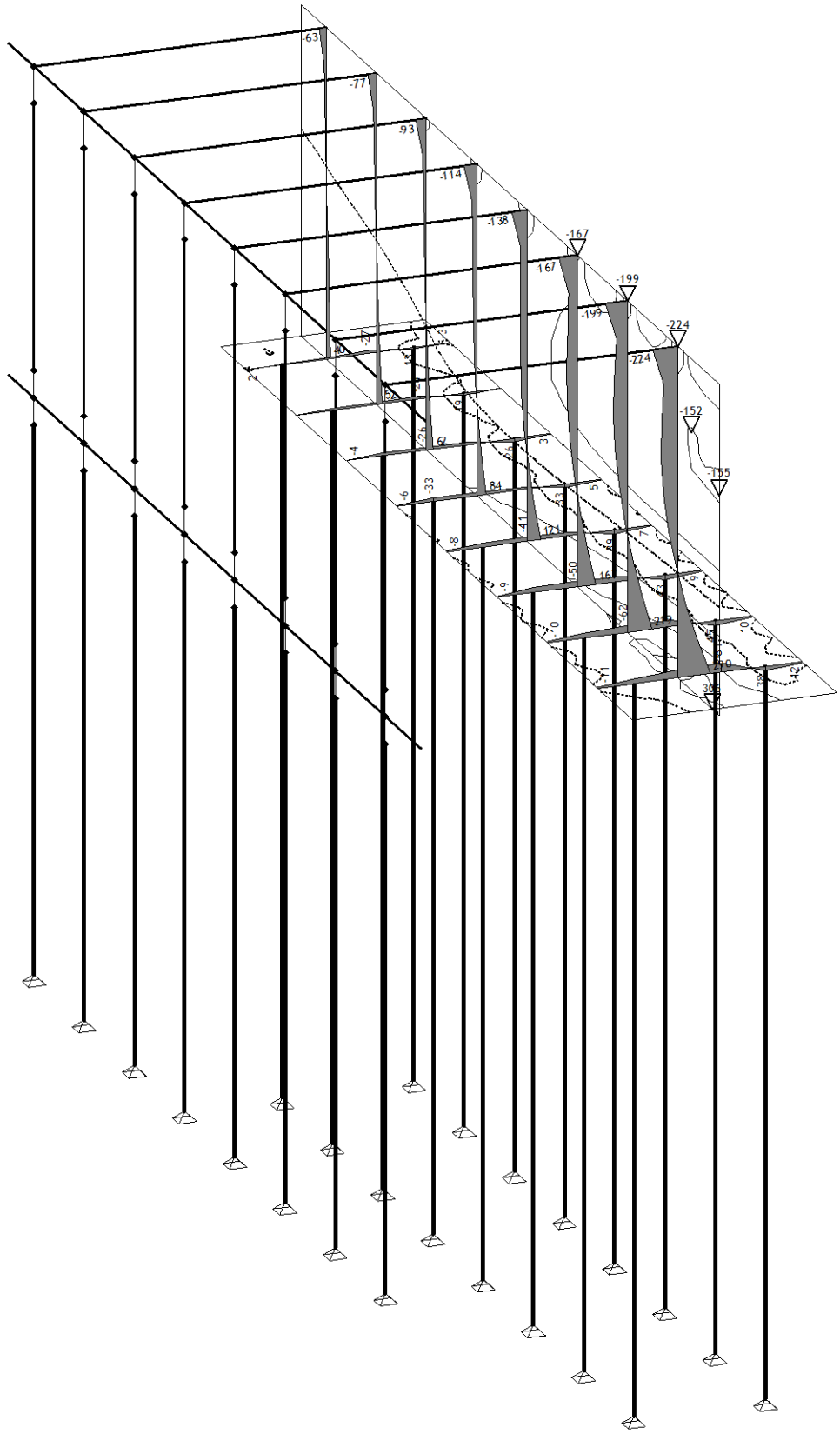
Isometric
Slab Results: max My= 714 / min My= -609 kNm/m

Load 2: Pritisak tla



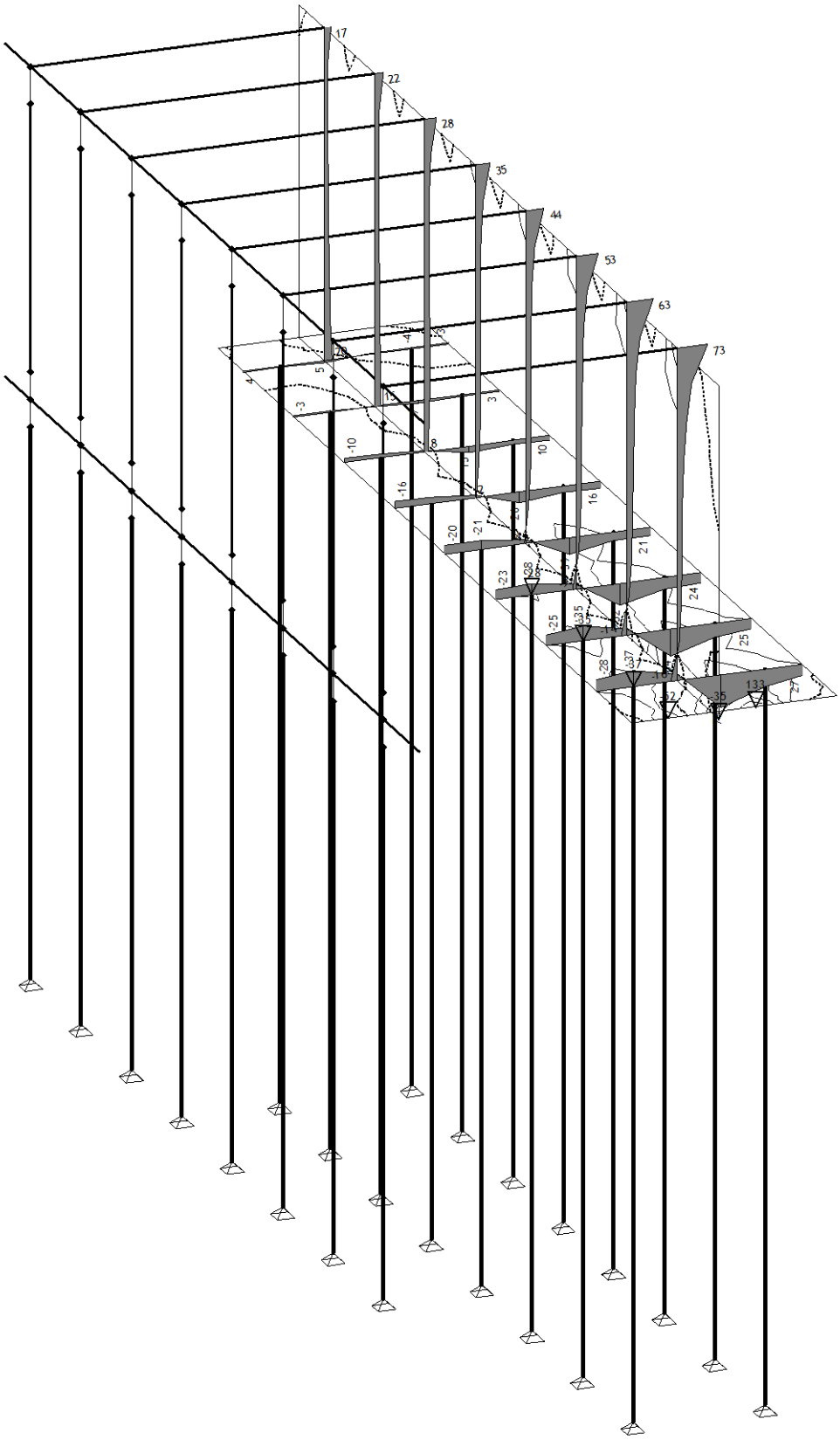
Isometric
Slab Results: max Ny= 344 / min Ny= -166 kN/m

Load 3: Voz na nasipu



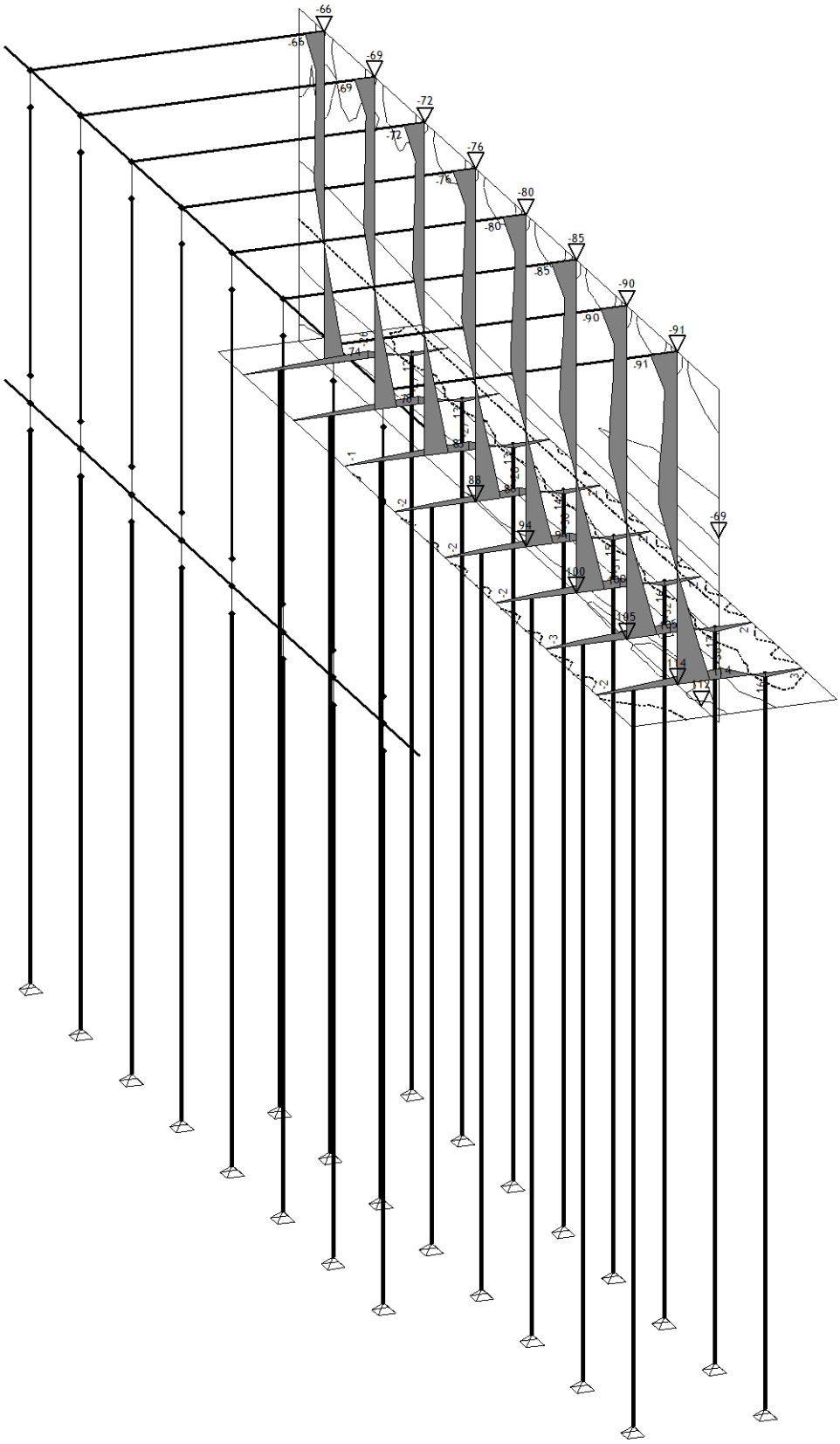
Isometric
Slab Results: max My= 306 / min My= -224 kNm/m

Load 3: Voz na nasipu



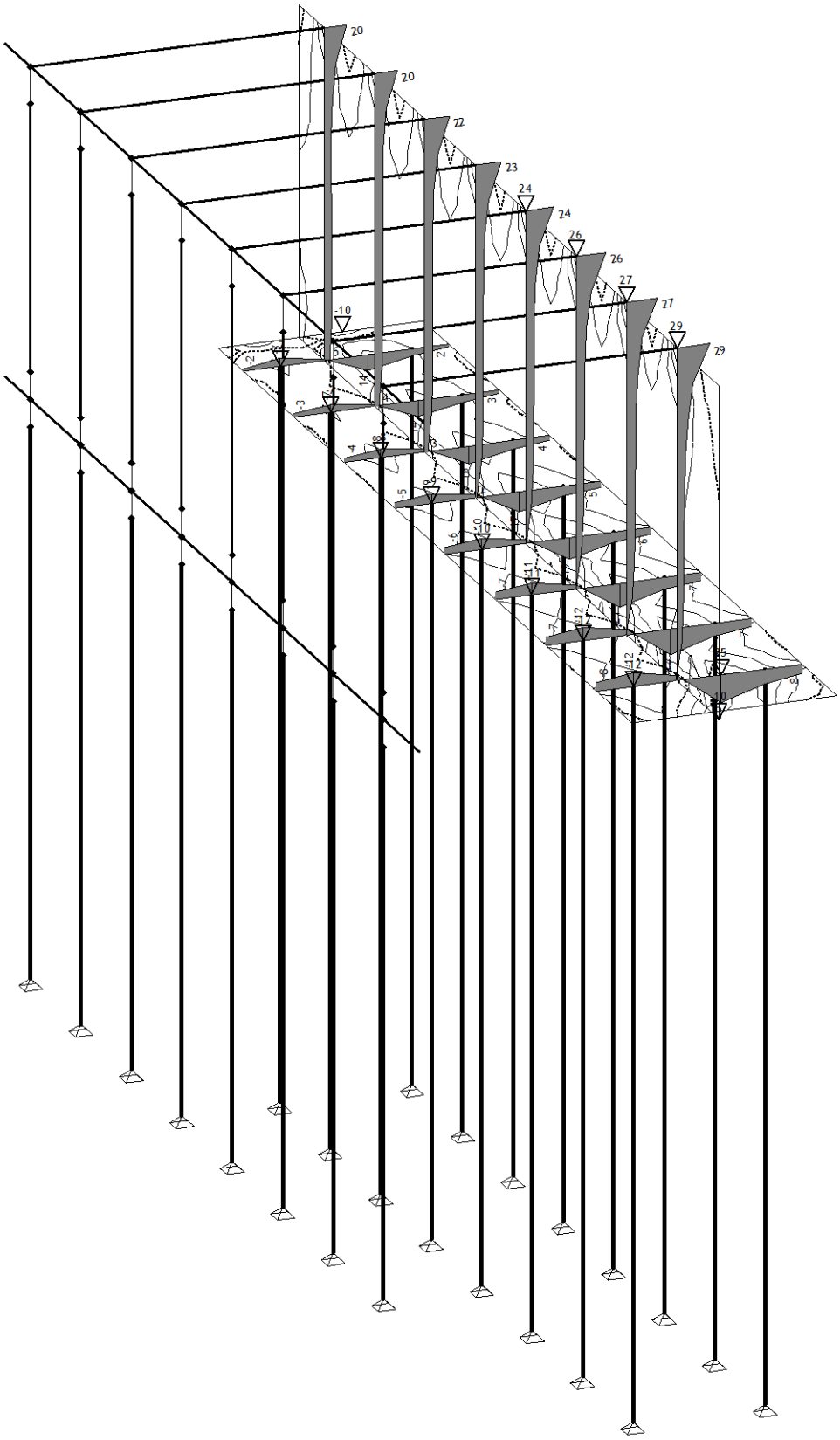
Isometric
Slab Results: max Ny= 133 / min Ny= -52 kN/m

Load 4: Seizmicki pritisak tla



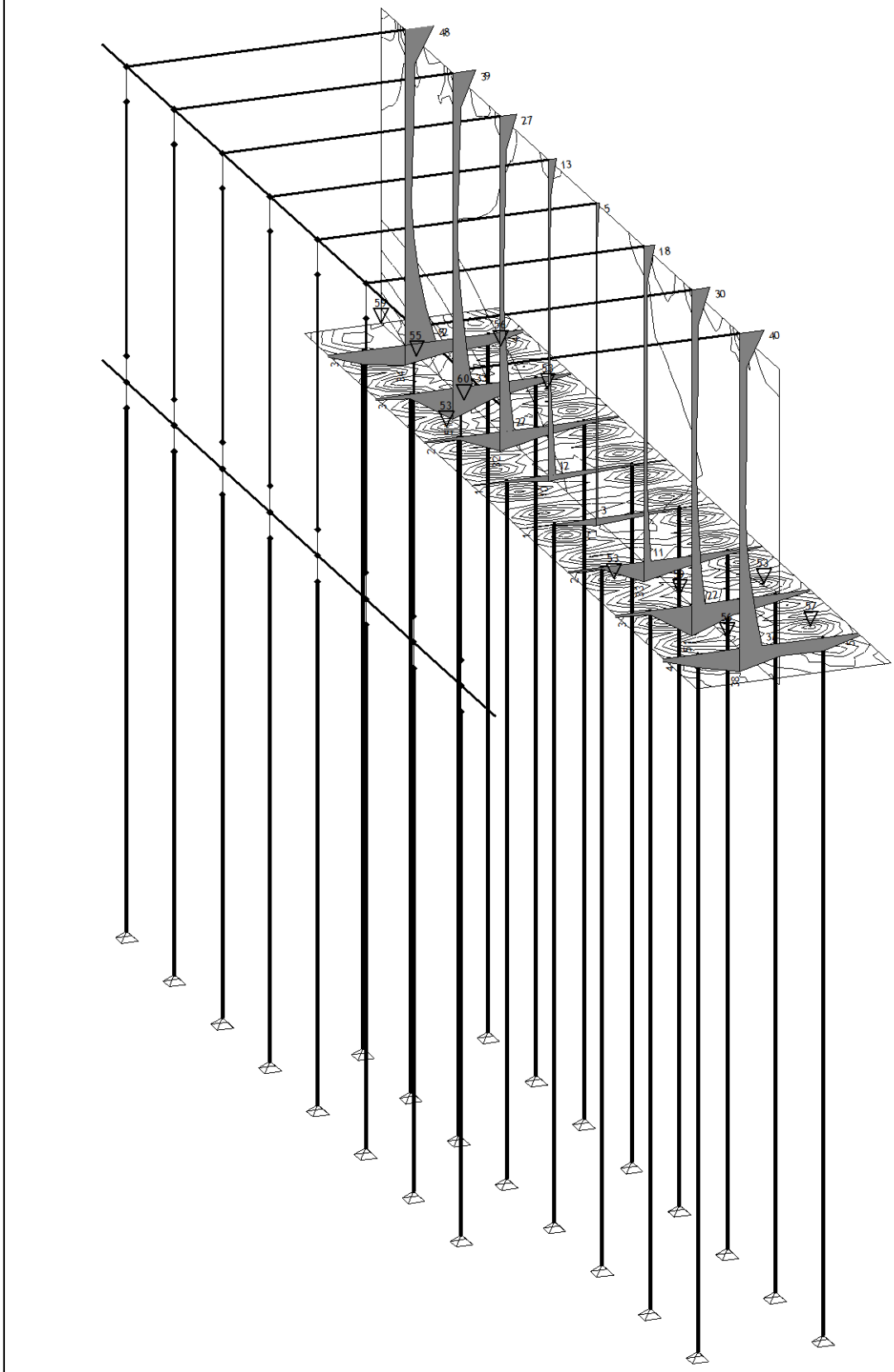
Isometric
Slab Results: max My= 114 / min My= -91 kNm/m

Load 4: Seizmicki pritisak tla



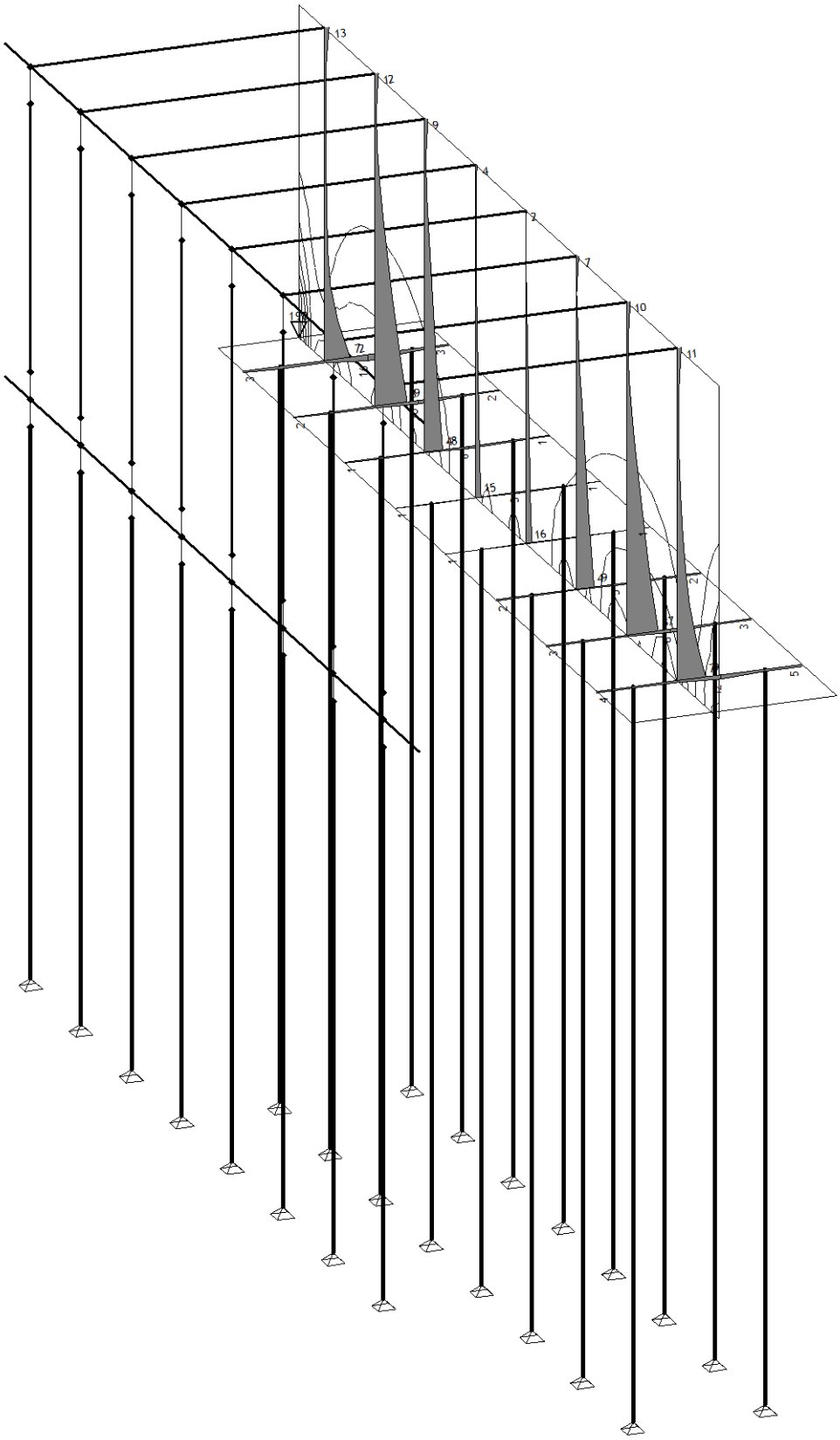
Isometric
Slab Results: max Ny= 29 / min Ny= -12 kN/m

Load 5: Sx



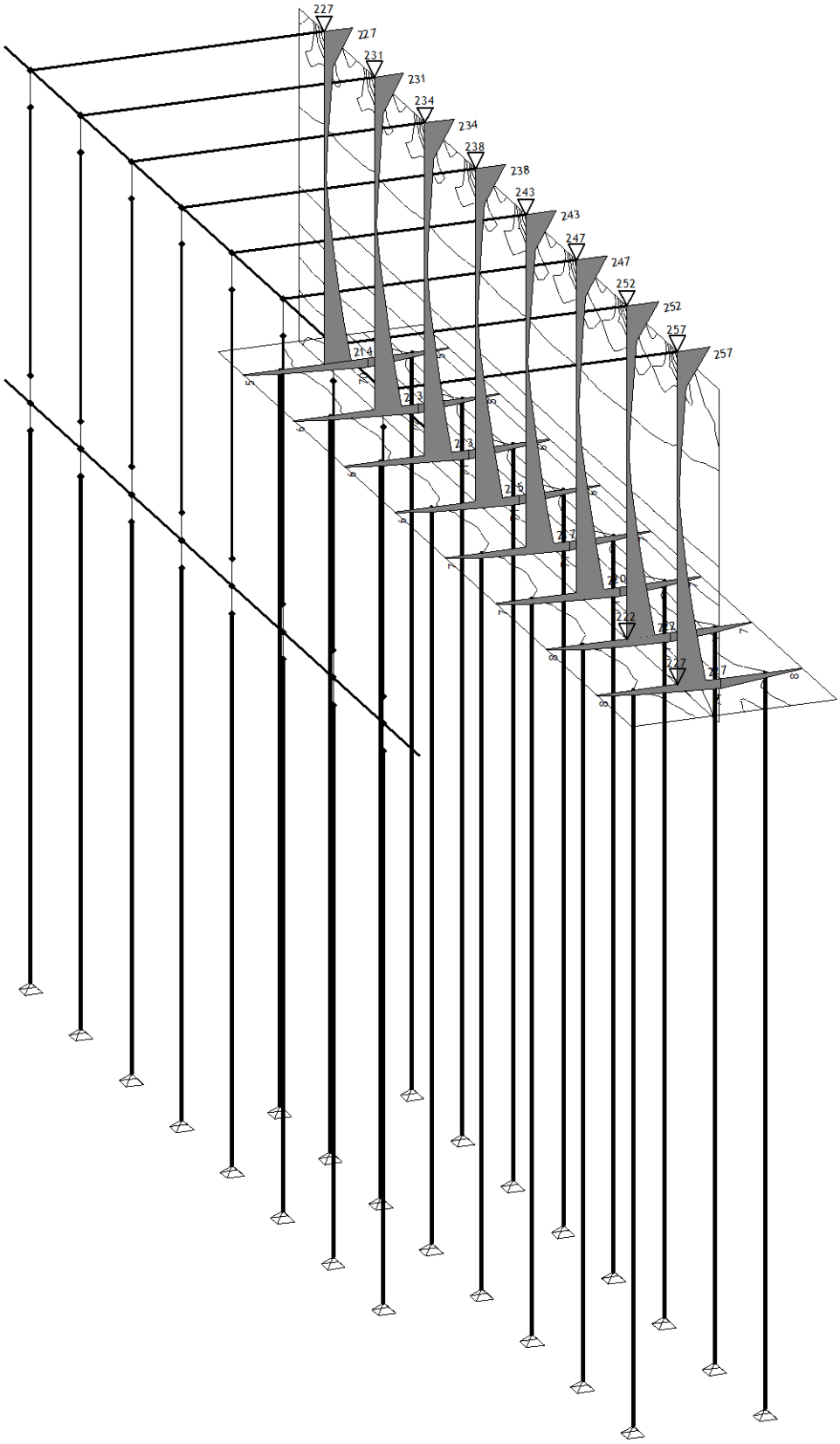
Isometric
Slab Results: max My= 60 / min My= 0 kNm/m

Load 5: Sx



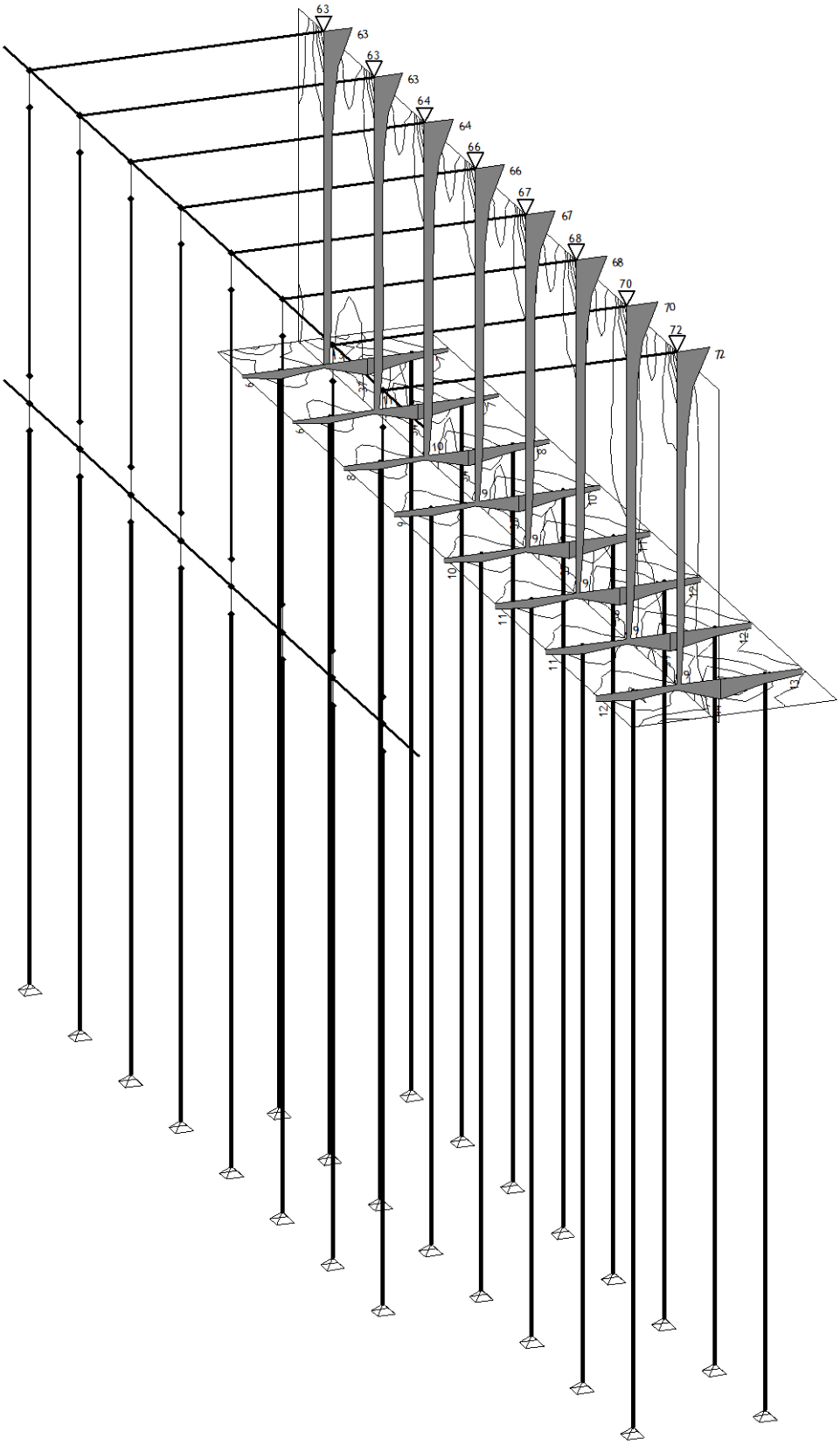
Isometric
Slab Results: max Ny= 190 / min Ny= 0 kN/m

Load 6: Sy



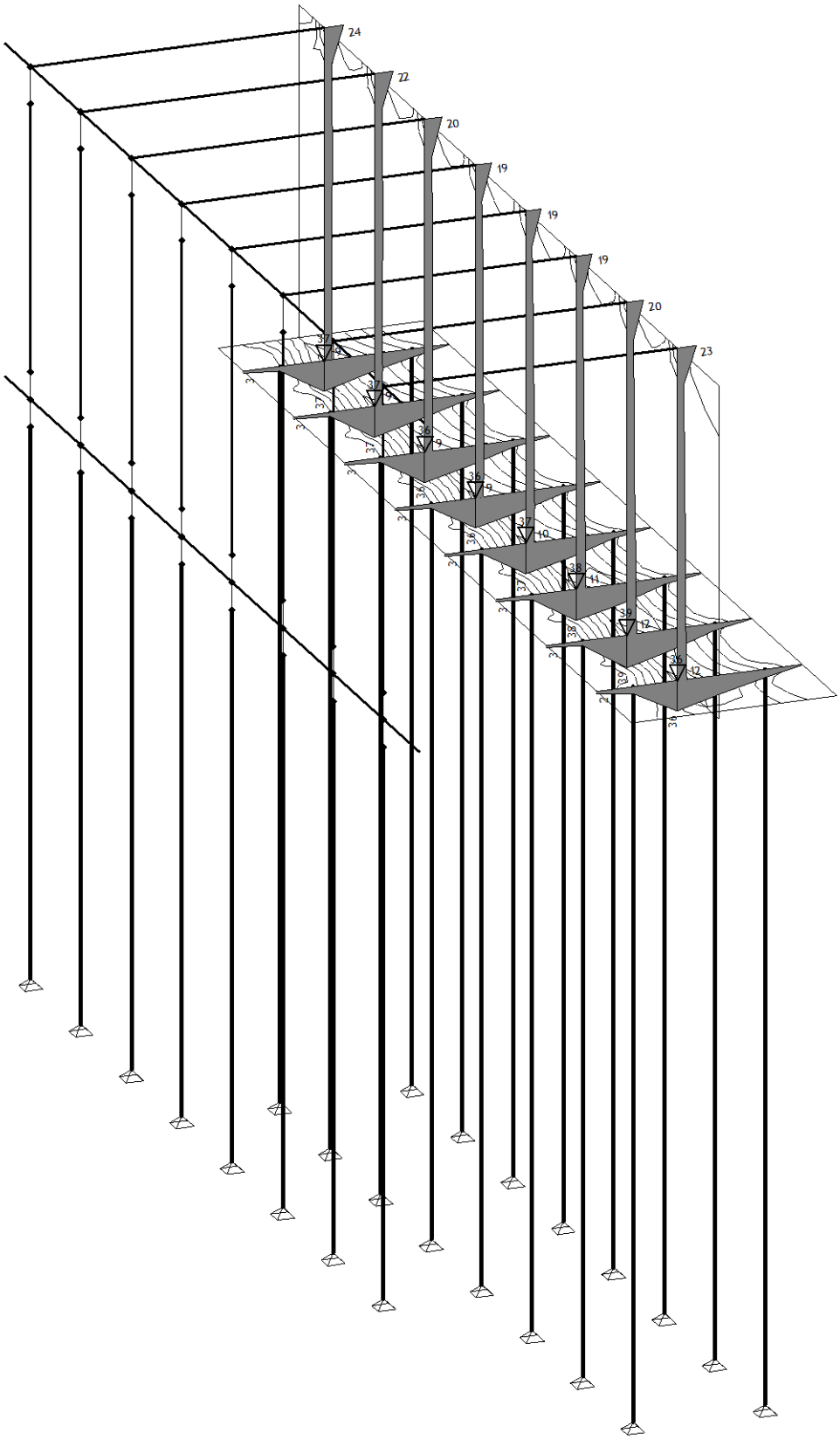
Isometric
Slab Results: max My= 257 / min My= 2 kNm/m

Load 6: Sy



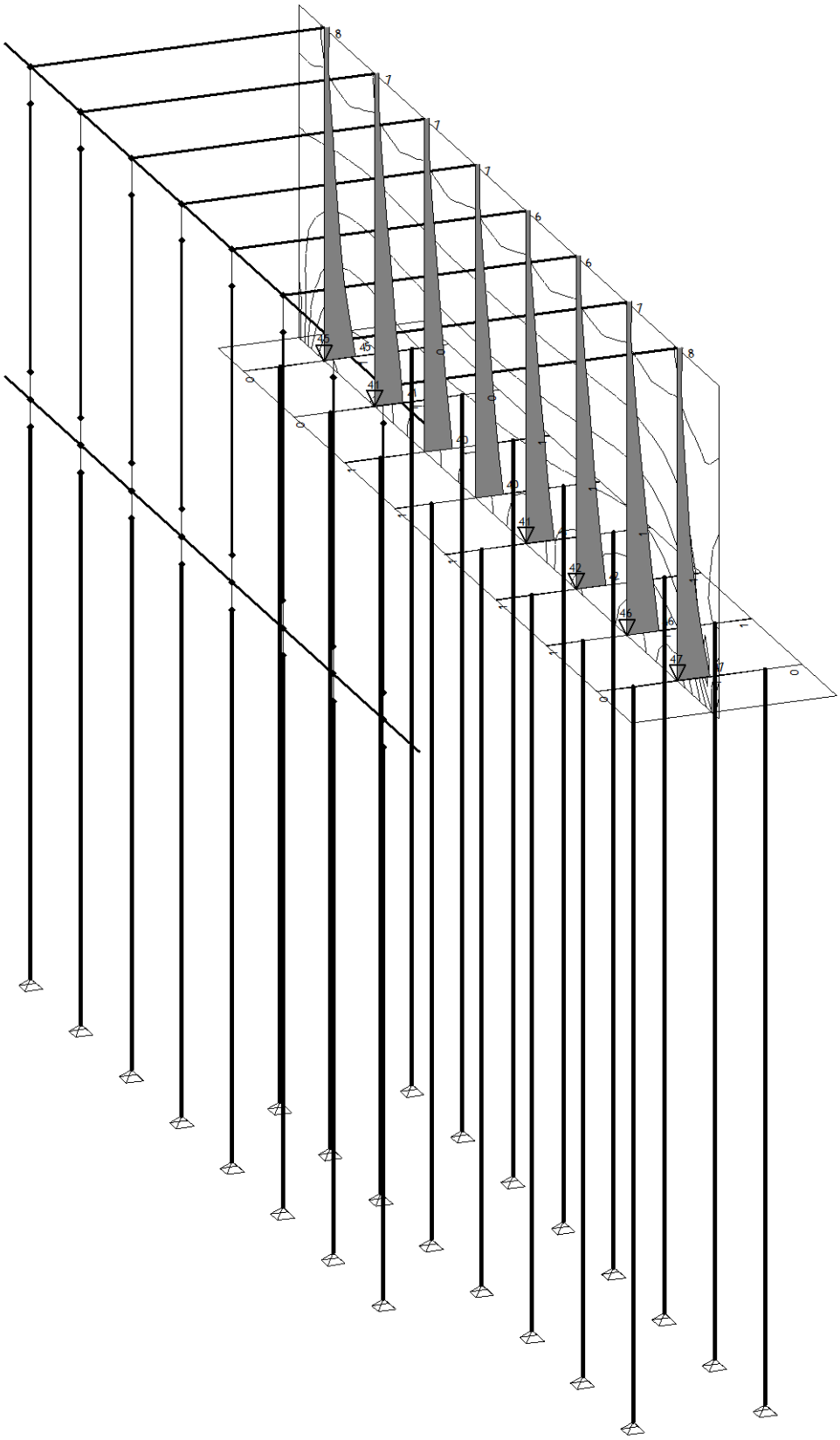
Isometric
Slab Results: max Ny= 72 / min Ny= 1 kN/m

Load 7: Sz



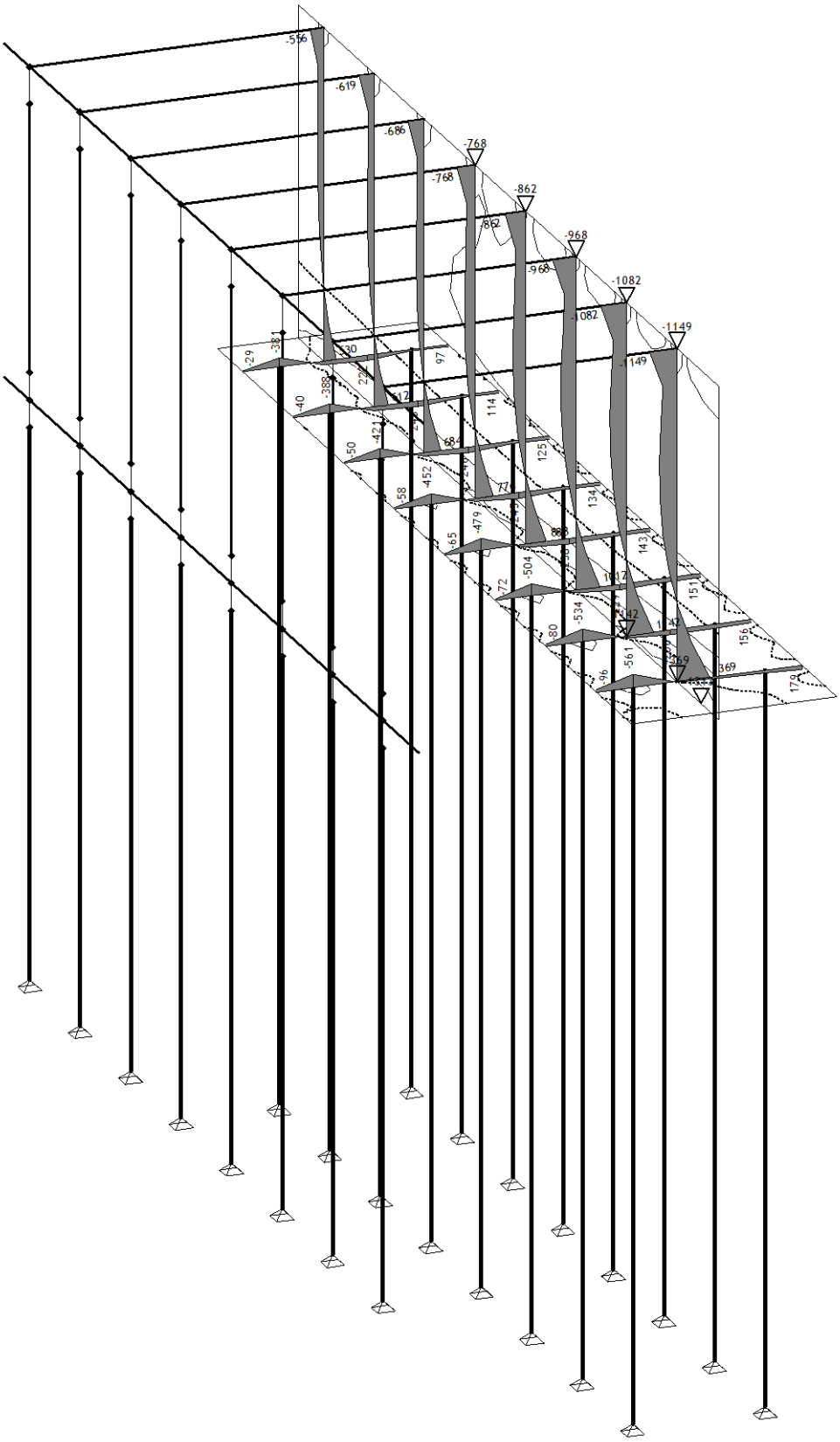
Isometric
Slab Results: max My= 39 / min My= 0 kNm/m

Load 7: Sz



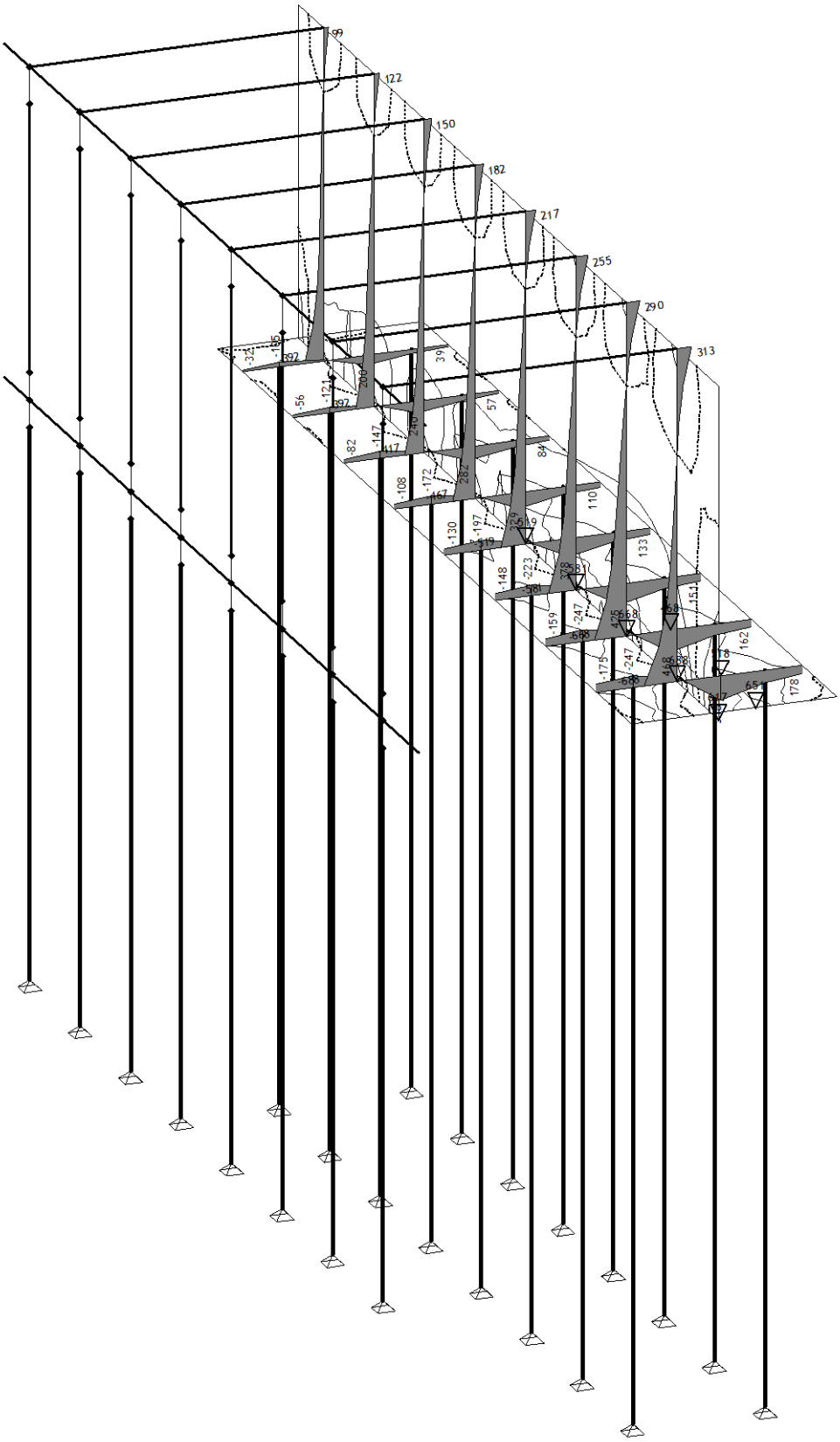
Isometric
Slab Results: max Ny= 47 / min Ny= 0 kN/m

Comb1
Load 8: 1.35xI+1.35xII+1.5xIII



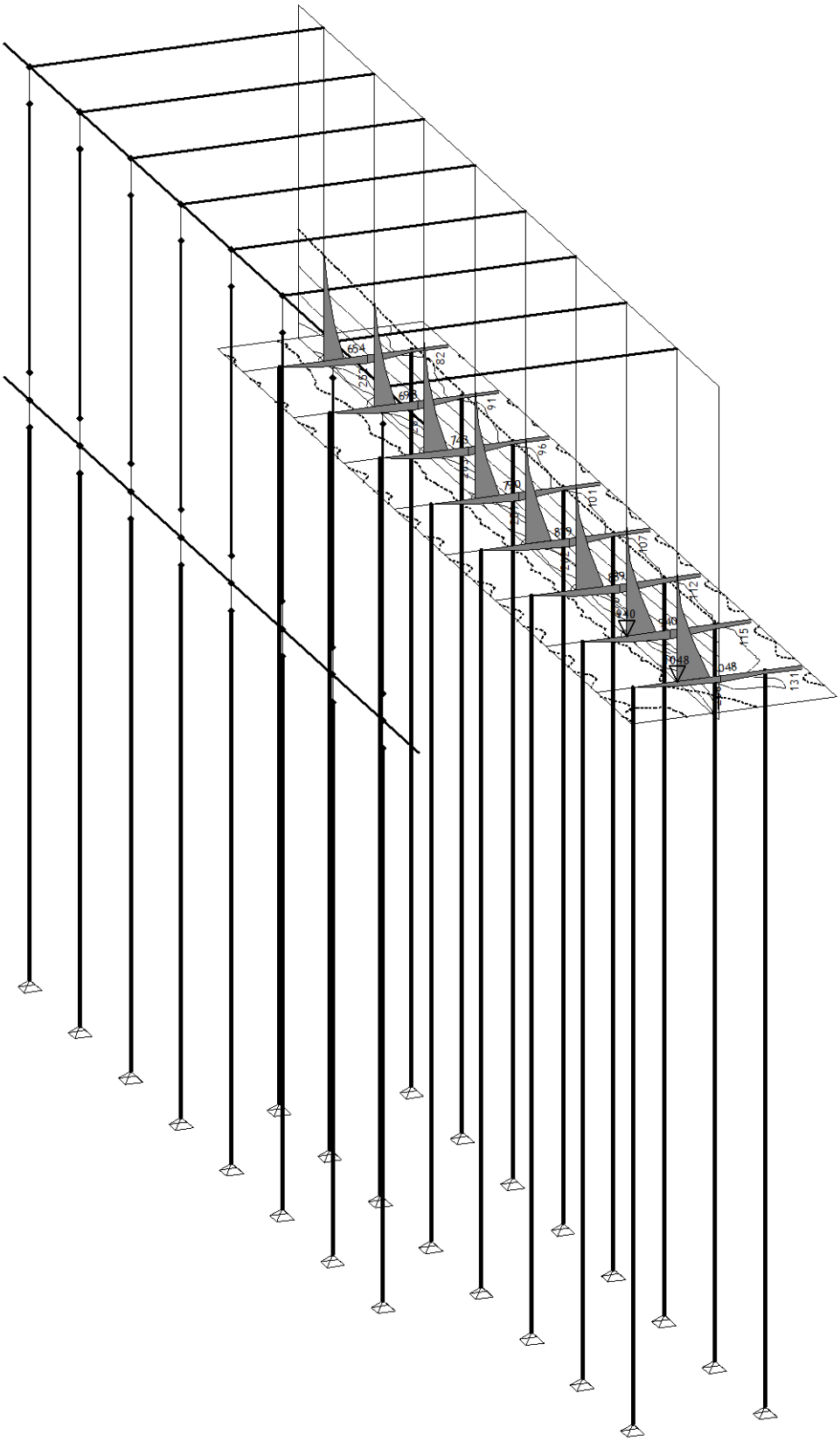
Isometric
Slab Results: max My= 1369 / min My= -1149 kNm/m

Comb1
Load 8: 1.35xI+1.35xII+1.5xIII



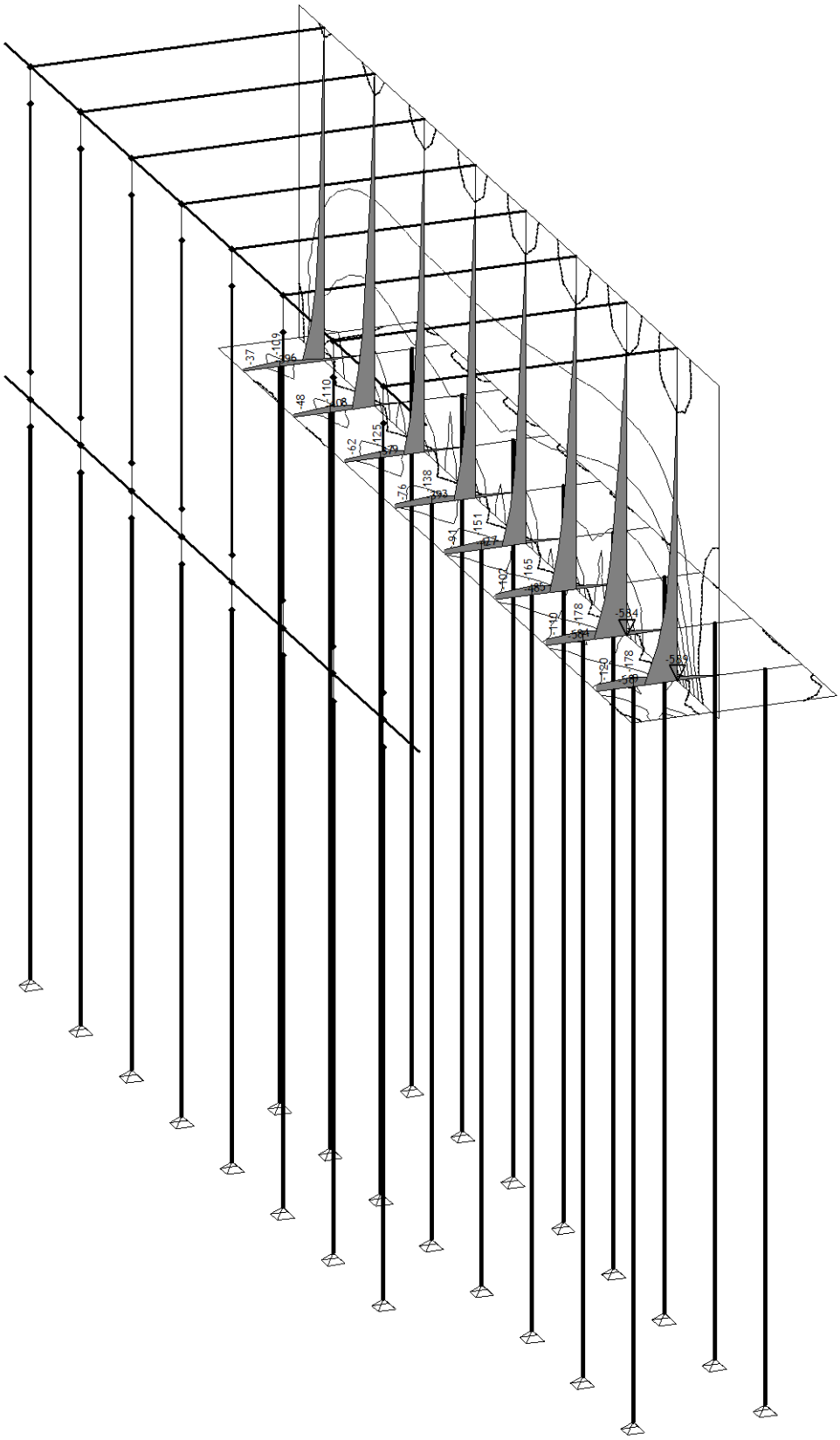
Isometric
Slab Results: max Ny= 651 / min Ny= -688 kN/m

Comb2
Load 12: [Anv] 9-11



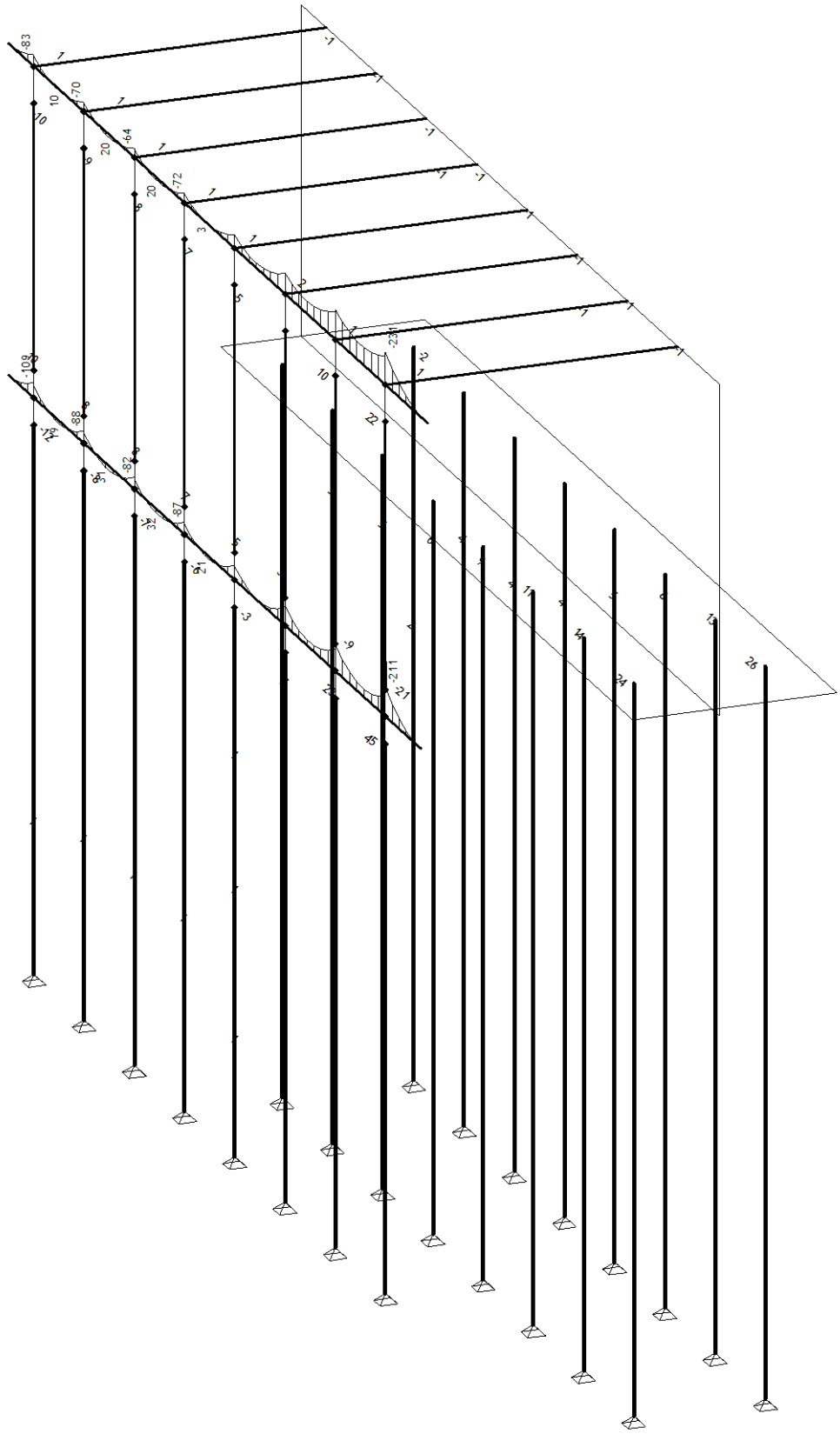
Isometric
Slab Results: max My= 1048 / min My= 0 kNm/m

Comb2
Load 12: [Anv] 9-11



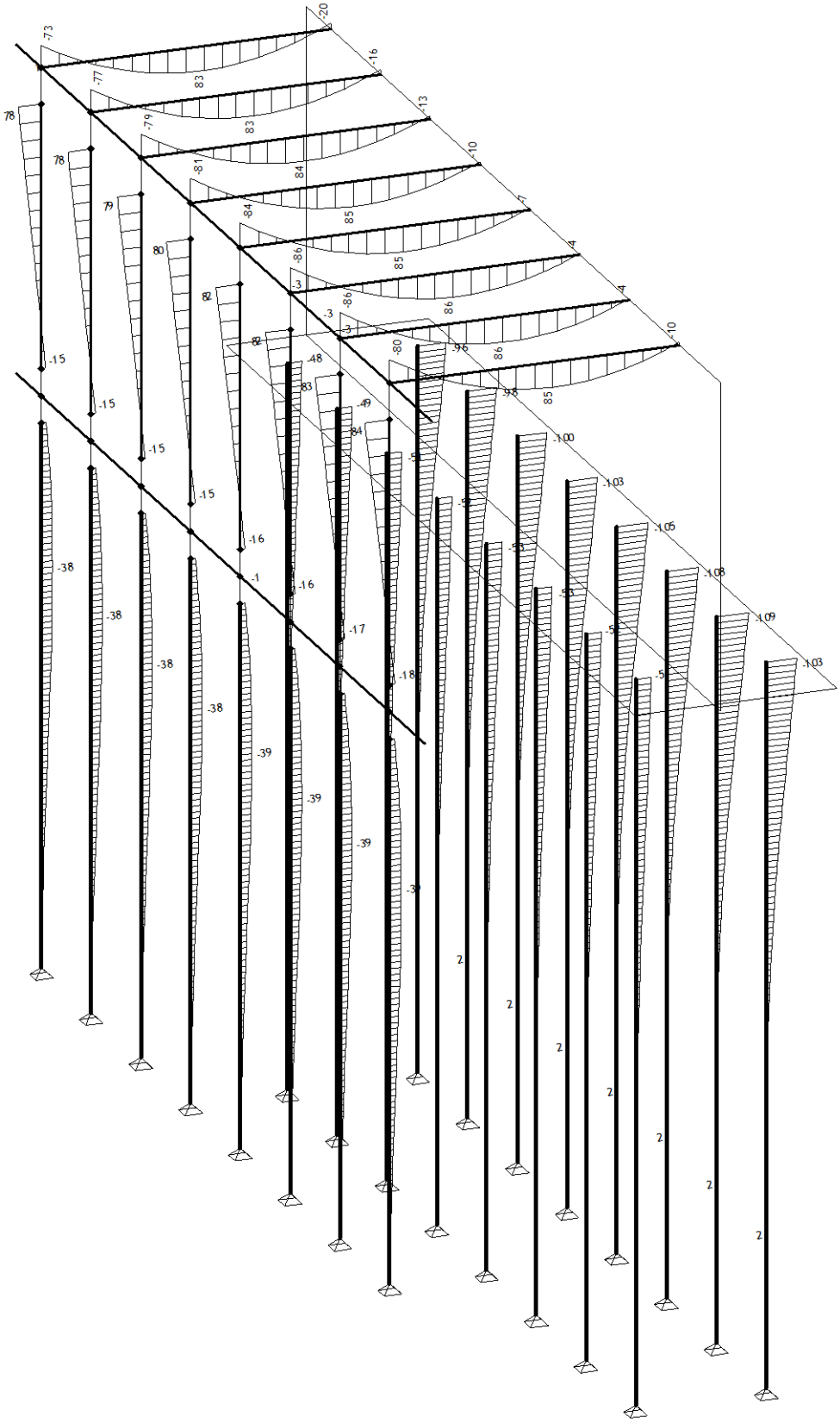
Isometric
Slab Results: max Ny= 0 / min Ny= -589 kN/m

Load 1: Sopstvena tezina (g)



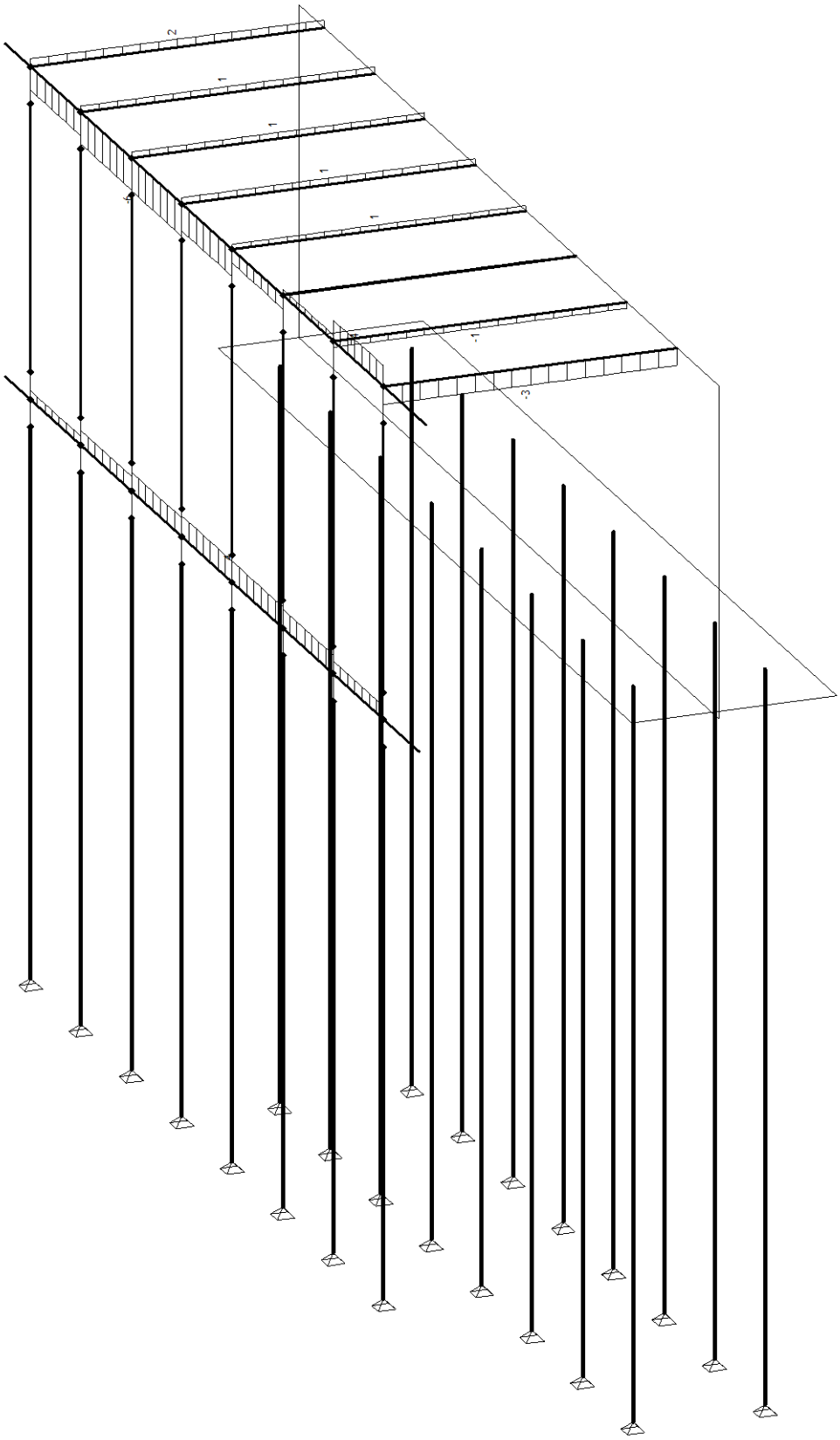
Isometric
Beam Results: max M3= 45 / min M3= -231 kNm

Load 1: Sopstvena tezina (g)



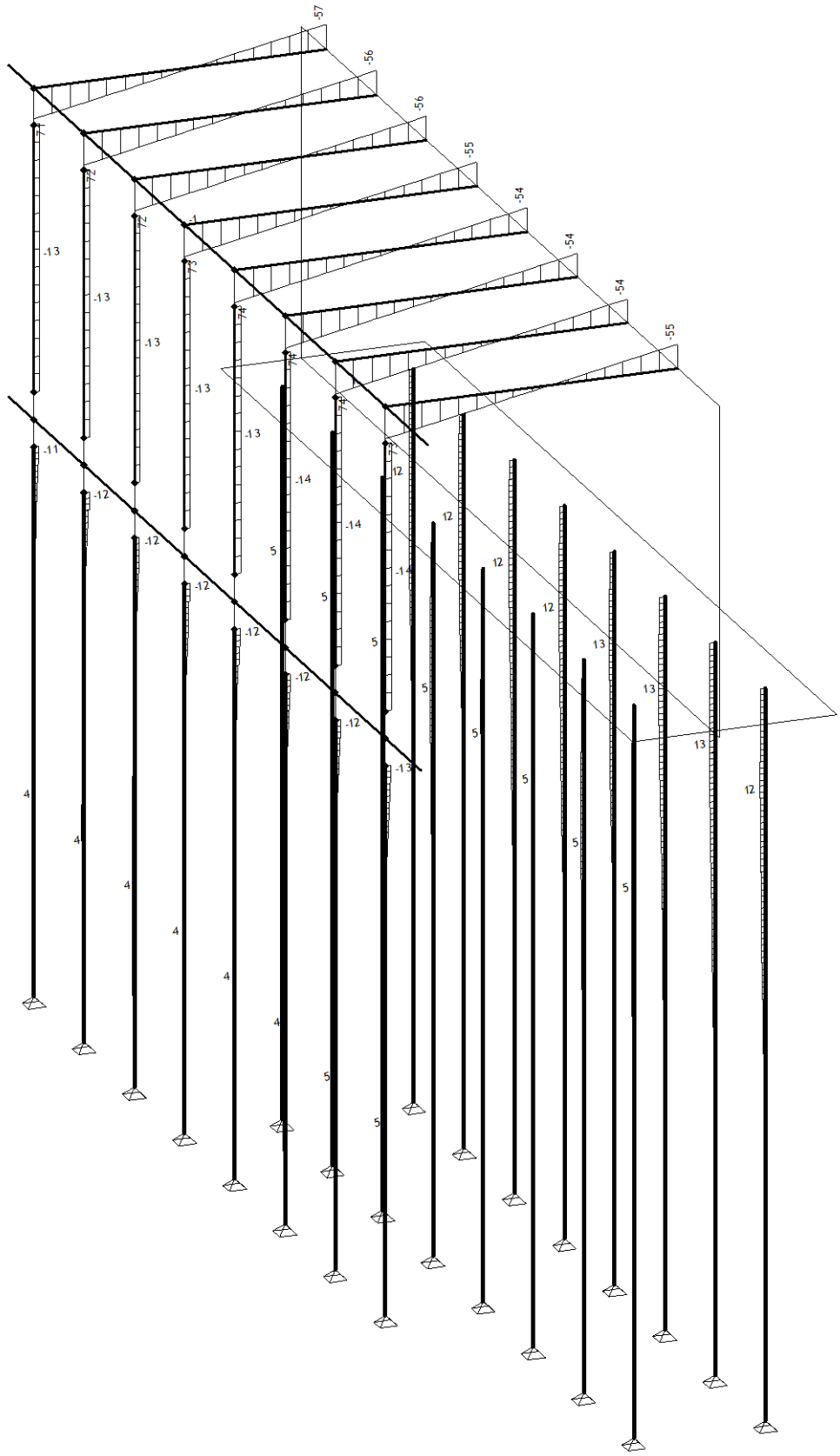
Isometric
Beam Results: max M2= 86 / min M2= -109 kNm

Load 1: Sopstvena tezina (g)



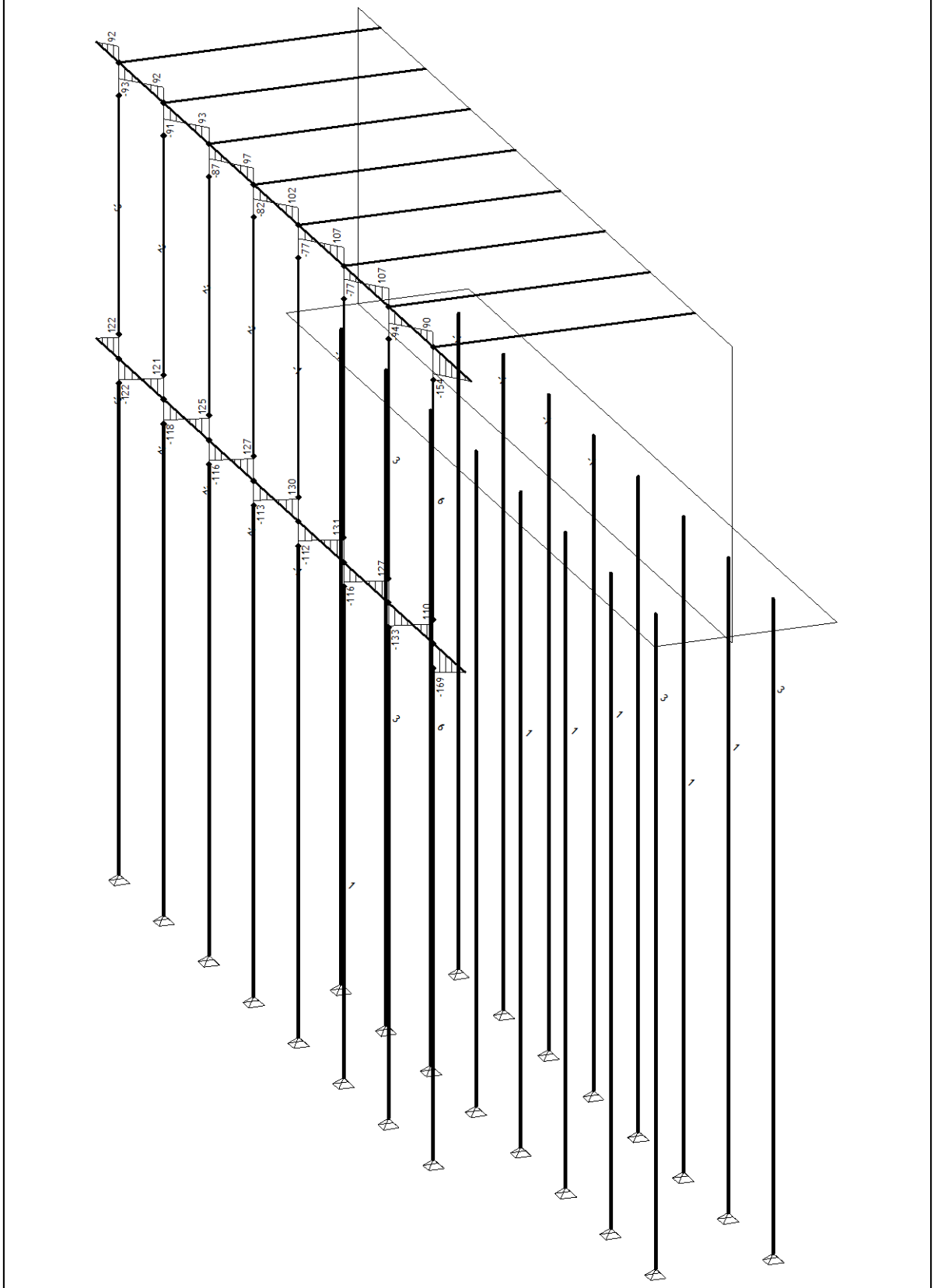
Isometric
Beam Results: max M1= 4 / min M1= -6 kNm

Load 1: Sopstvena tezina (g)



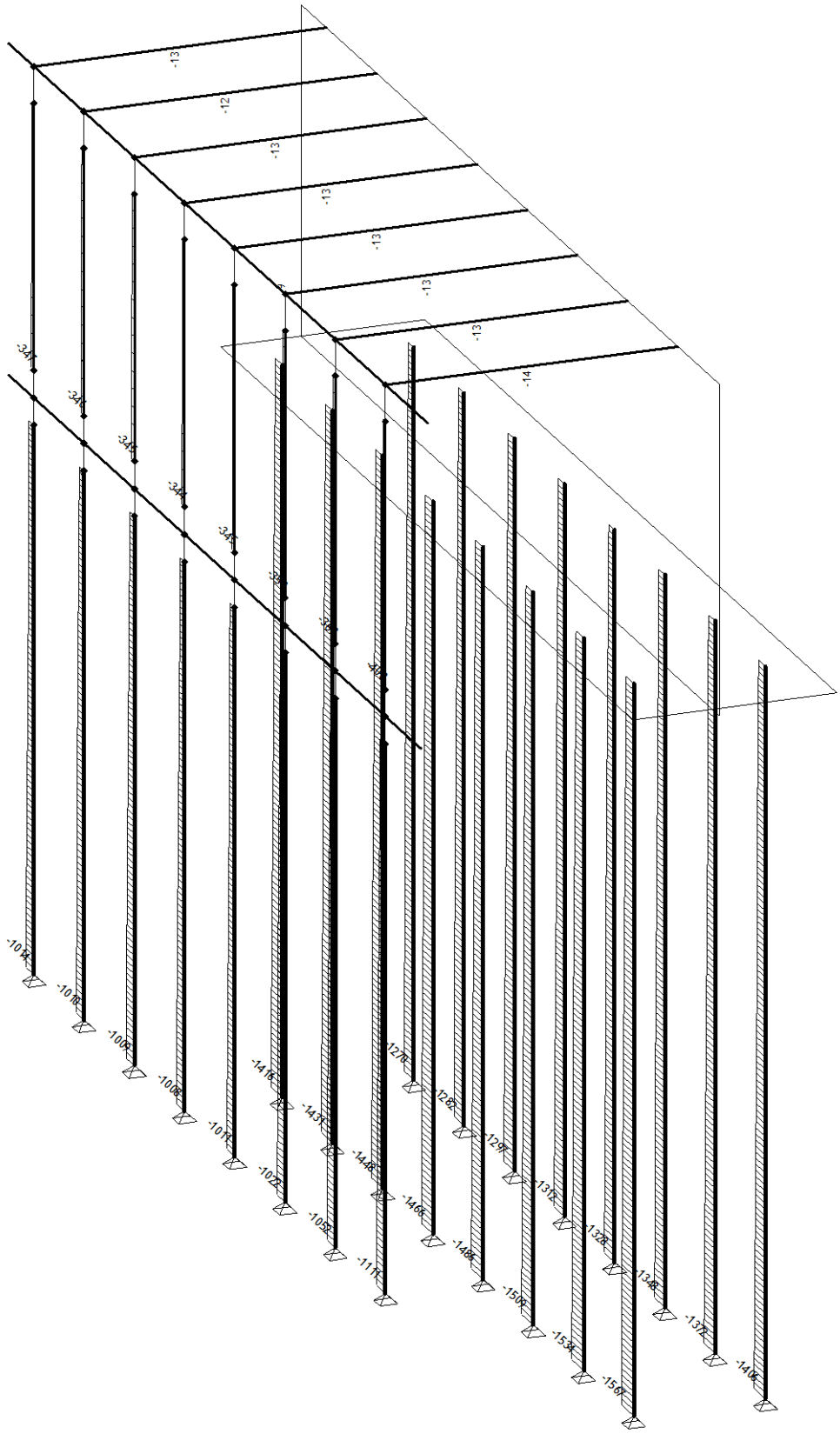
Isometric
Beam Results: max V3= 74 / min V3= -57 kN

Load 1: Sopstvena tezina (g)



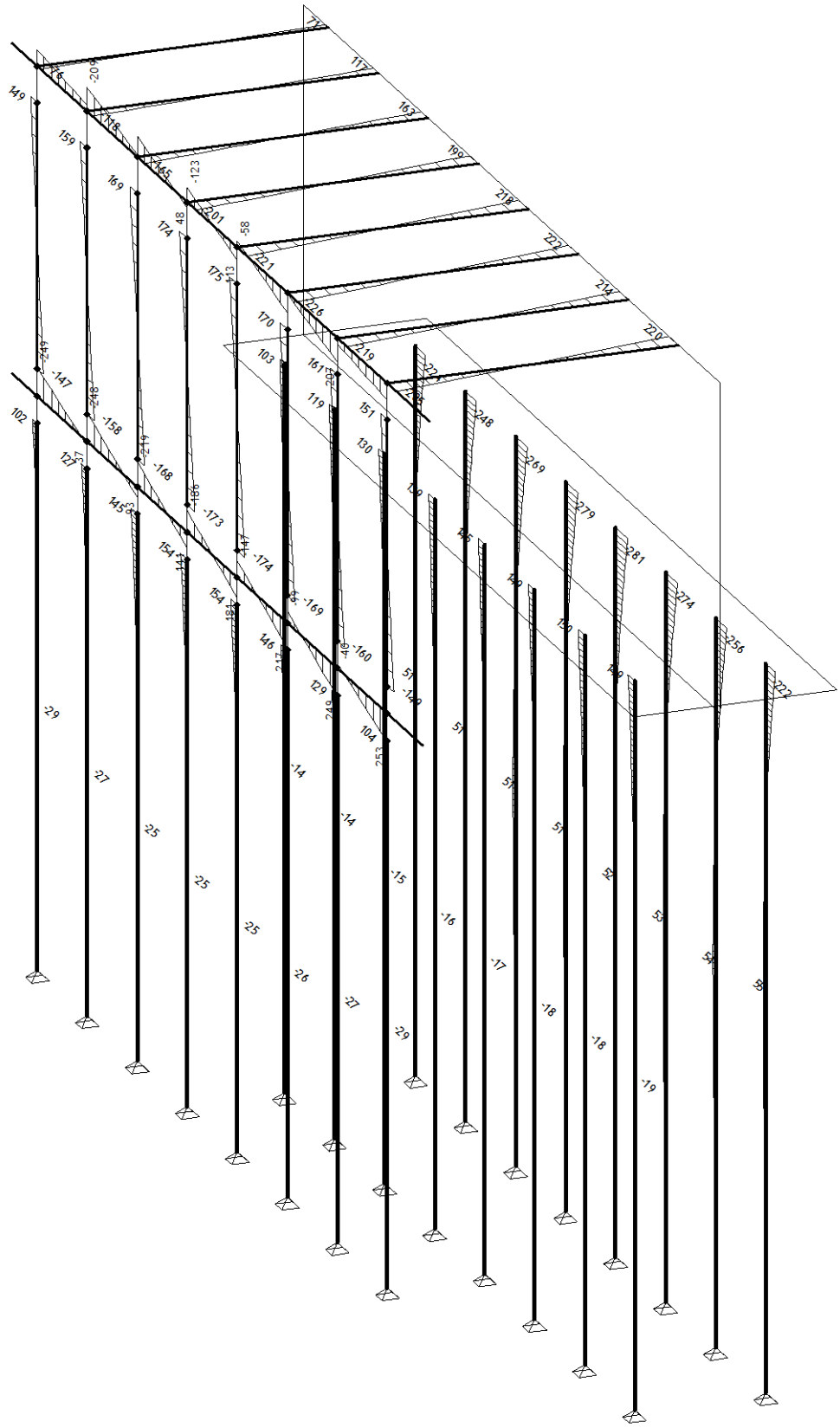
Isometric
Beam Results: max V2= 131 / min V2= -169 kN

Load 1: Sopstvena tezina (g)



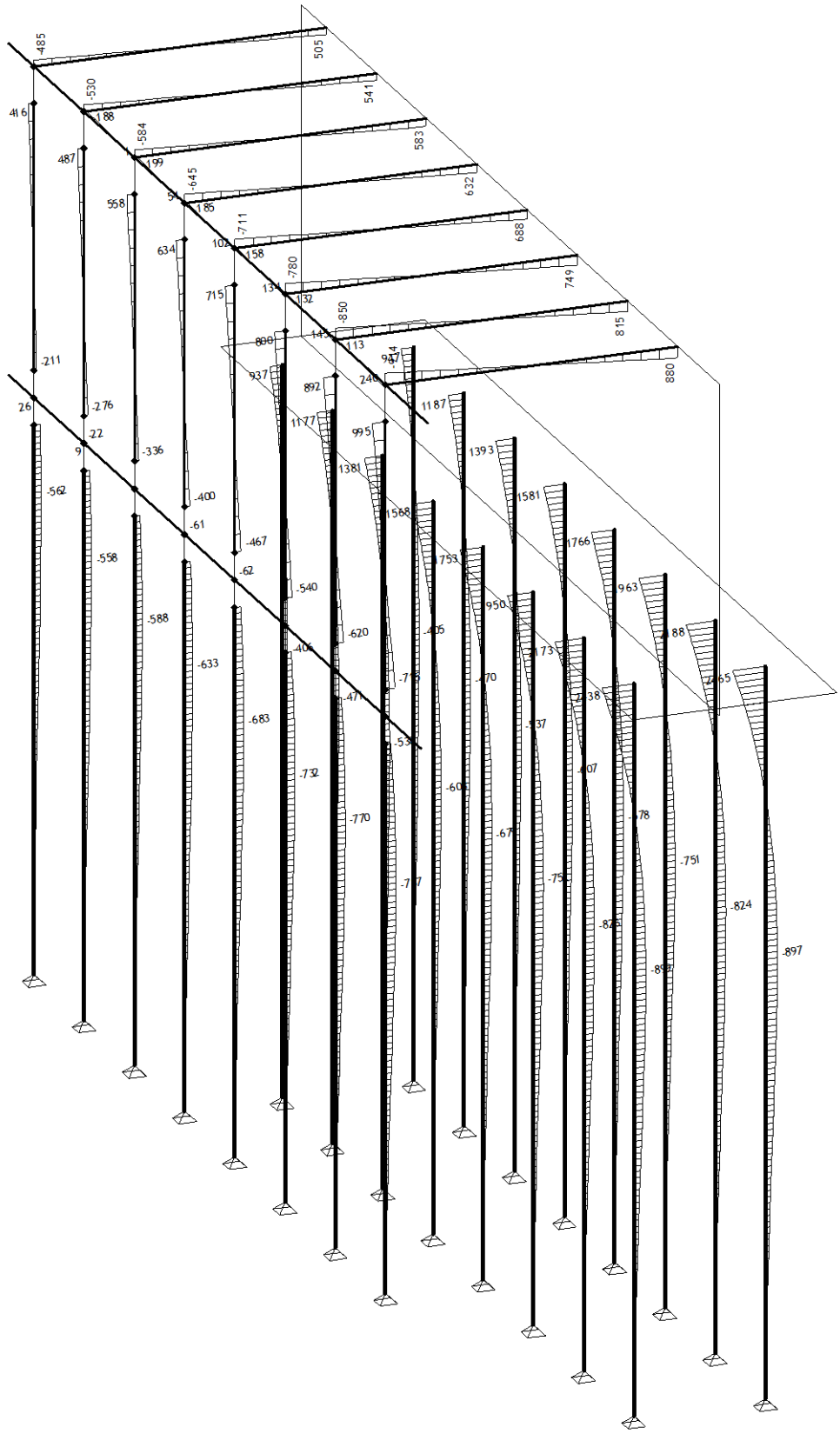
Isometric
Beam Results: max N1= 9 / min N1= -1567 kN

Load 2: Pritisak tla



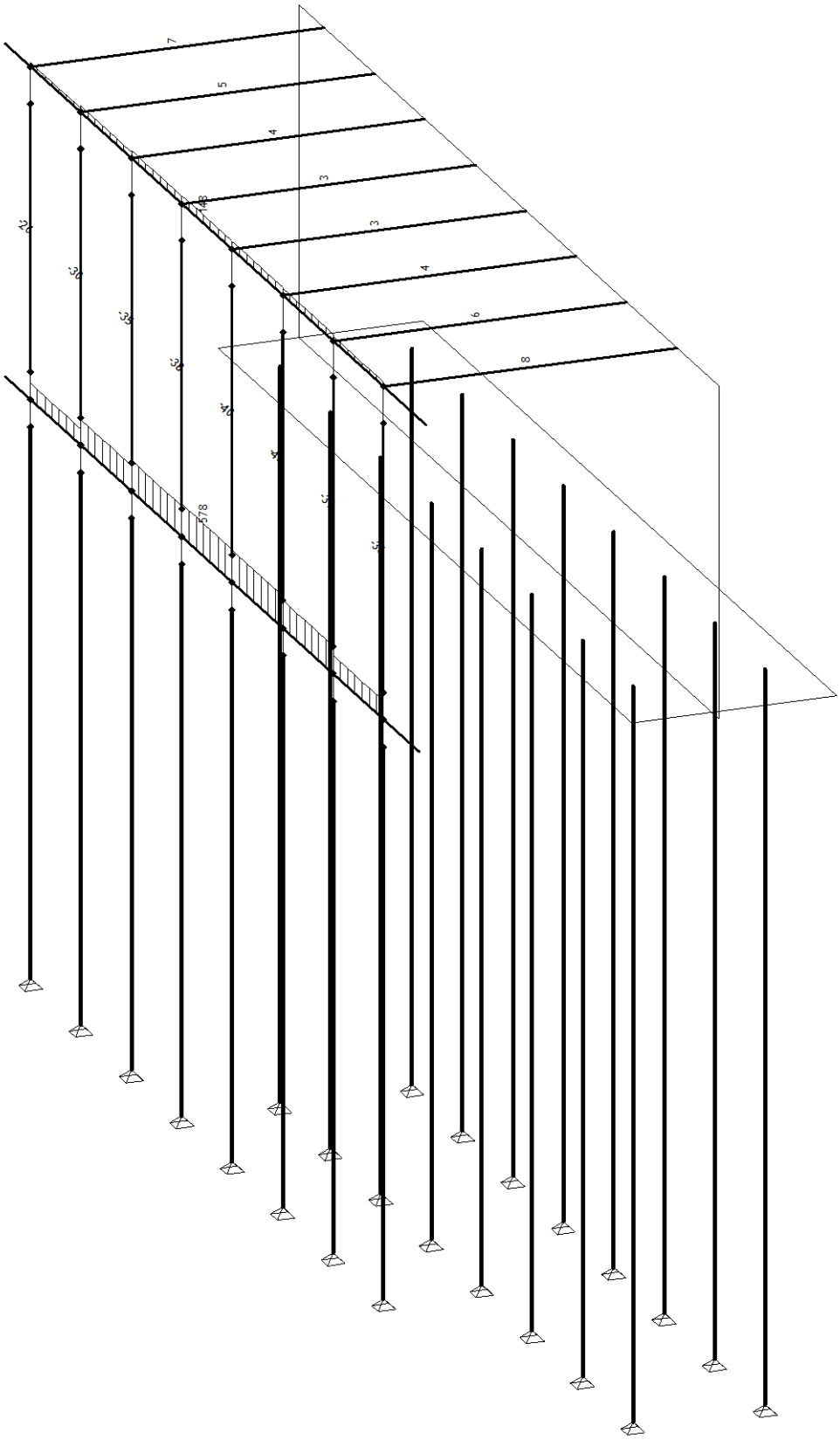
Isometric
Beam Results: max M3= 253 / min M3= -281 kNm

Load 2: Pritisak tla



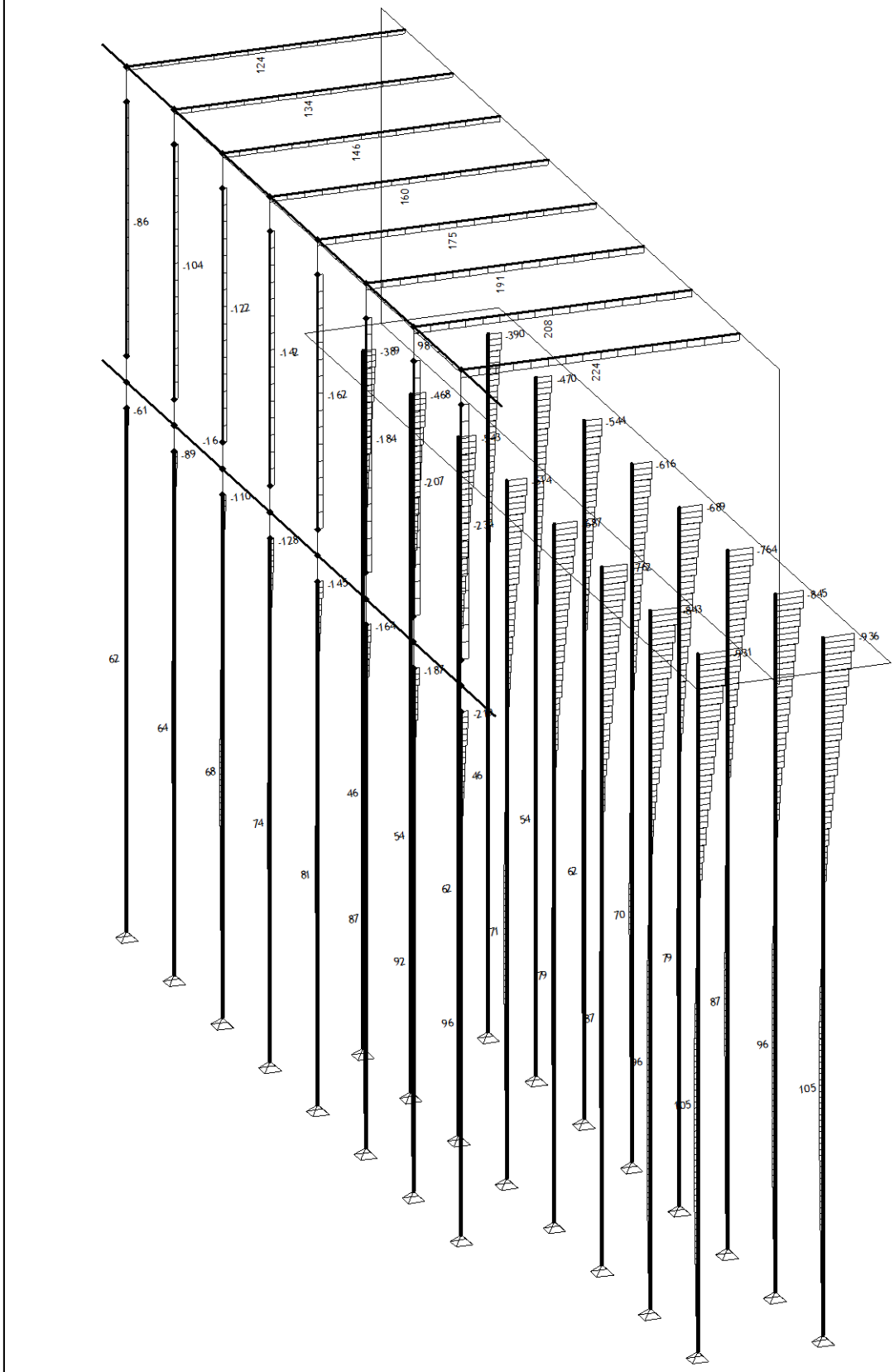
Isometric
Beam Results: max M2= 2465 / min M2= -914 kNm

Load 2: Pritisak tla



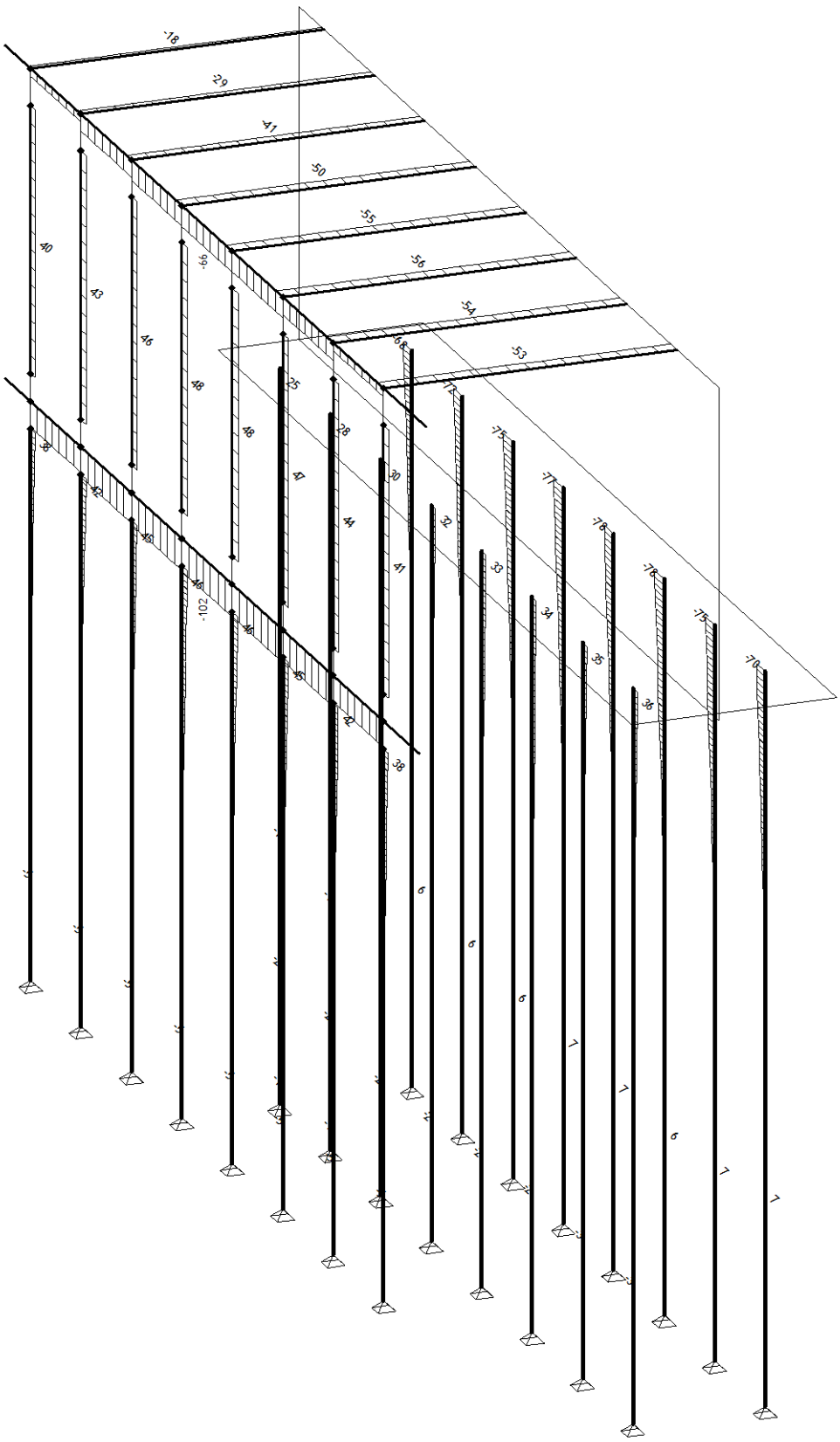
Isometric
Beam Results: max M1= 578 / min M1= -40 kNm

Load 2: Pritisak tla



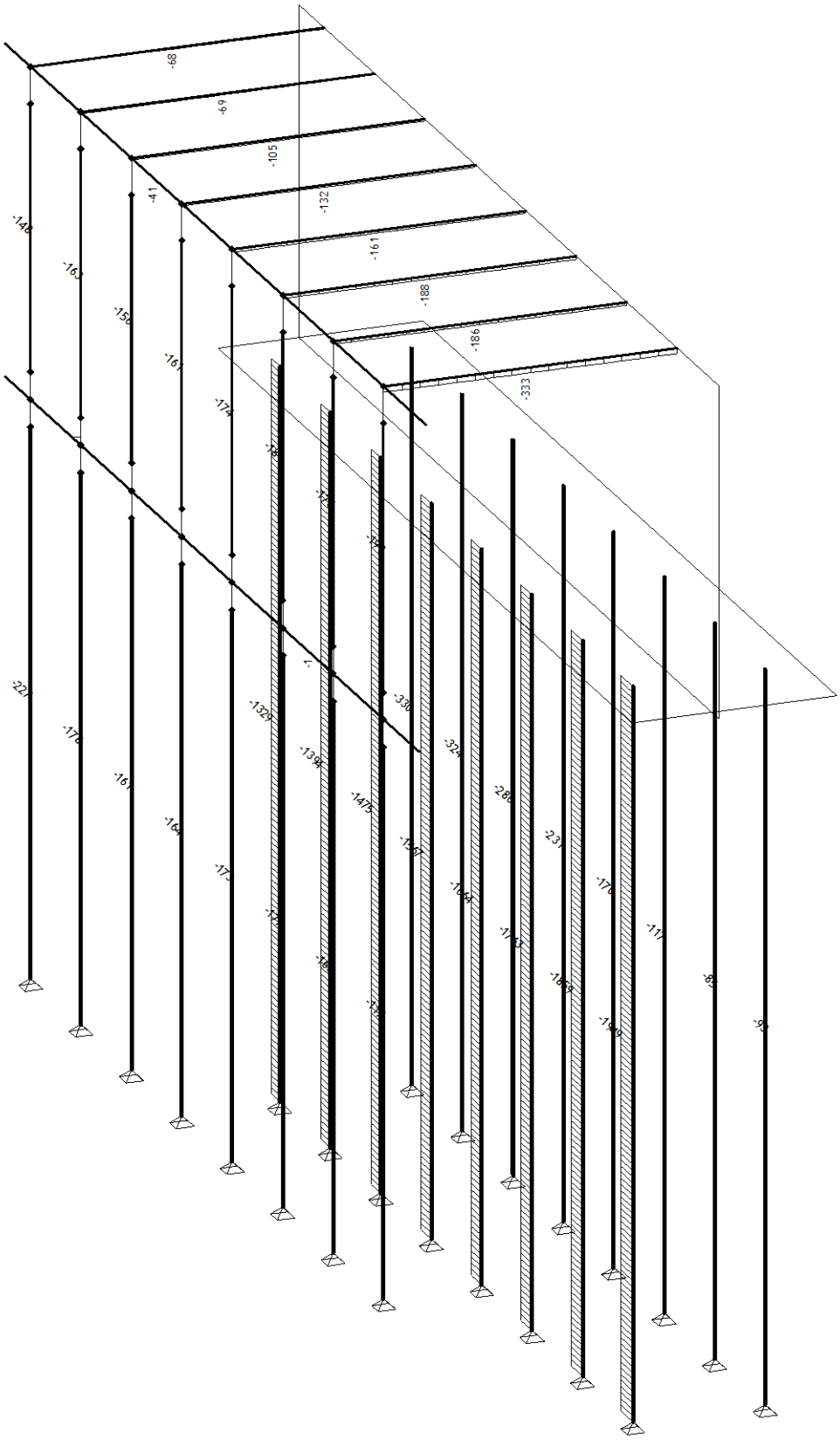
Isometric
Beam Results: max V3= 224 / min V3= -936 kN

Load 2: Pritisak tla



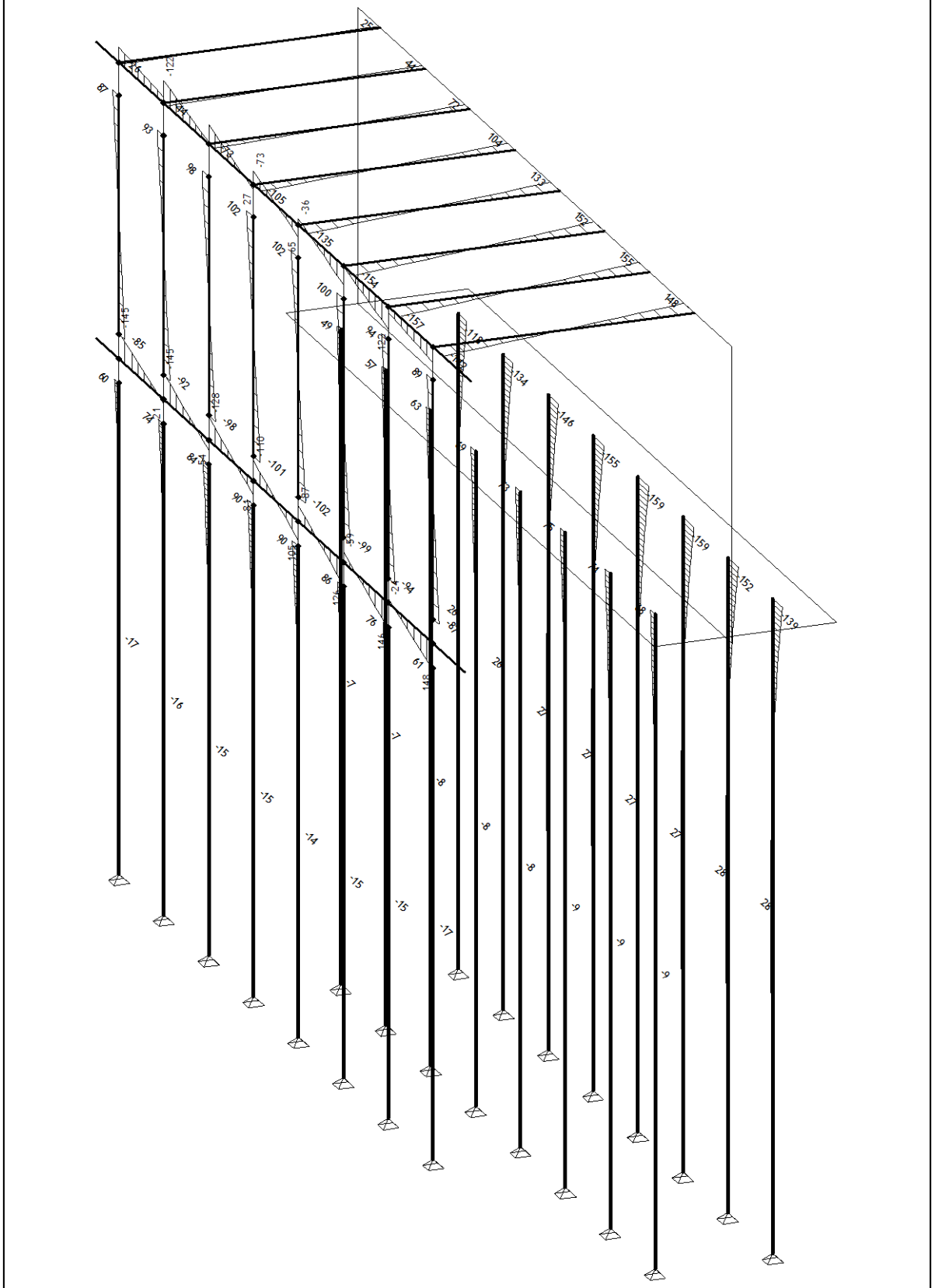
Isometric
Beam Results: max V2= 48 / min V2= -102 kN

Load 2: Pritisak tla



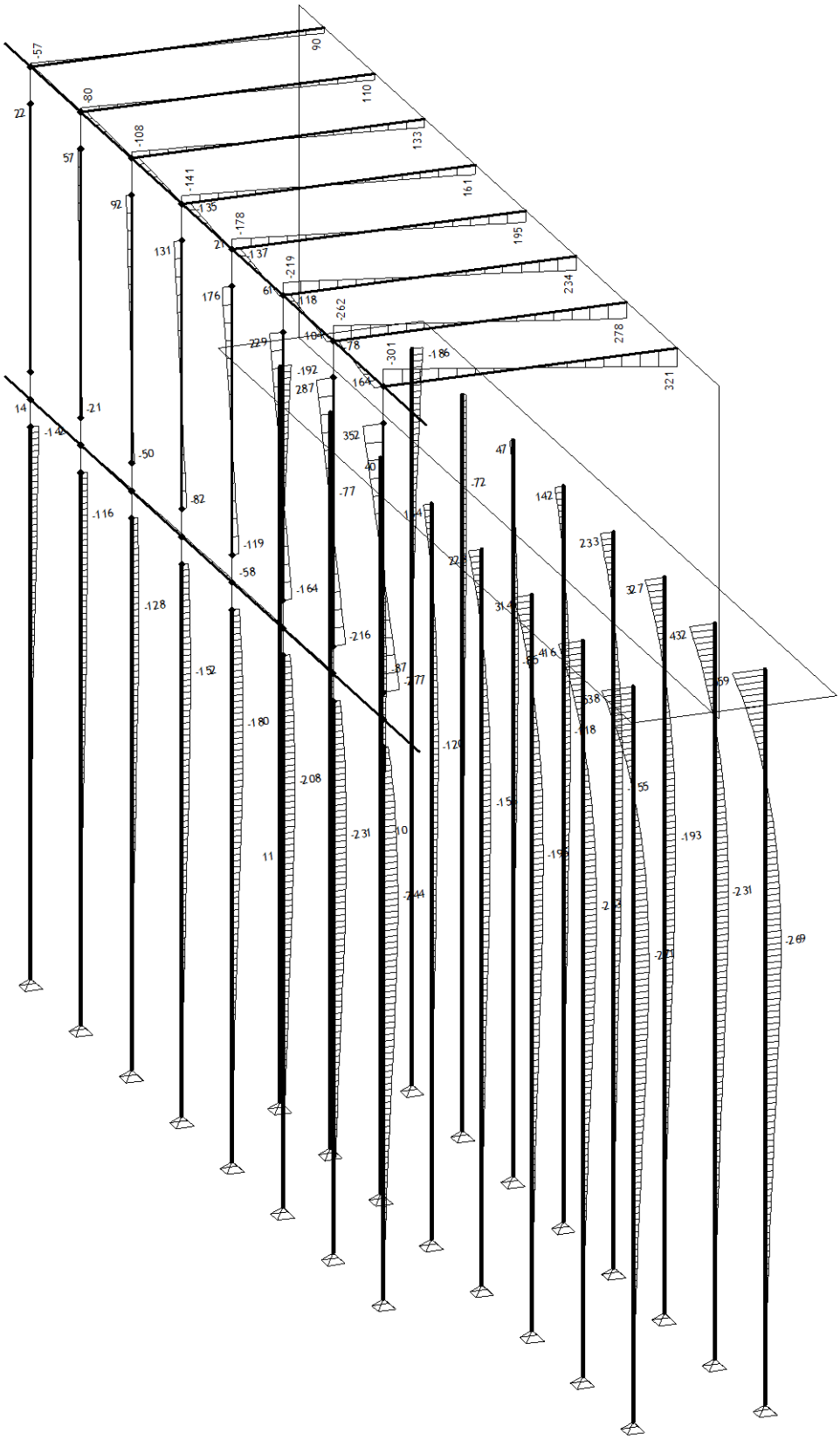
Isometric
Beam Results: max N1= 1 / min N1= -1949 kN

Load 3: Voz na nasipu



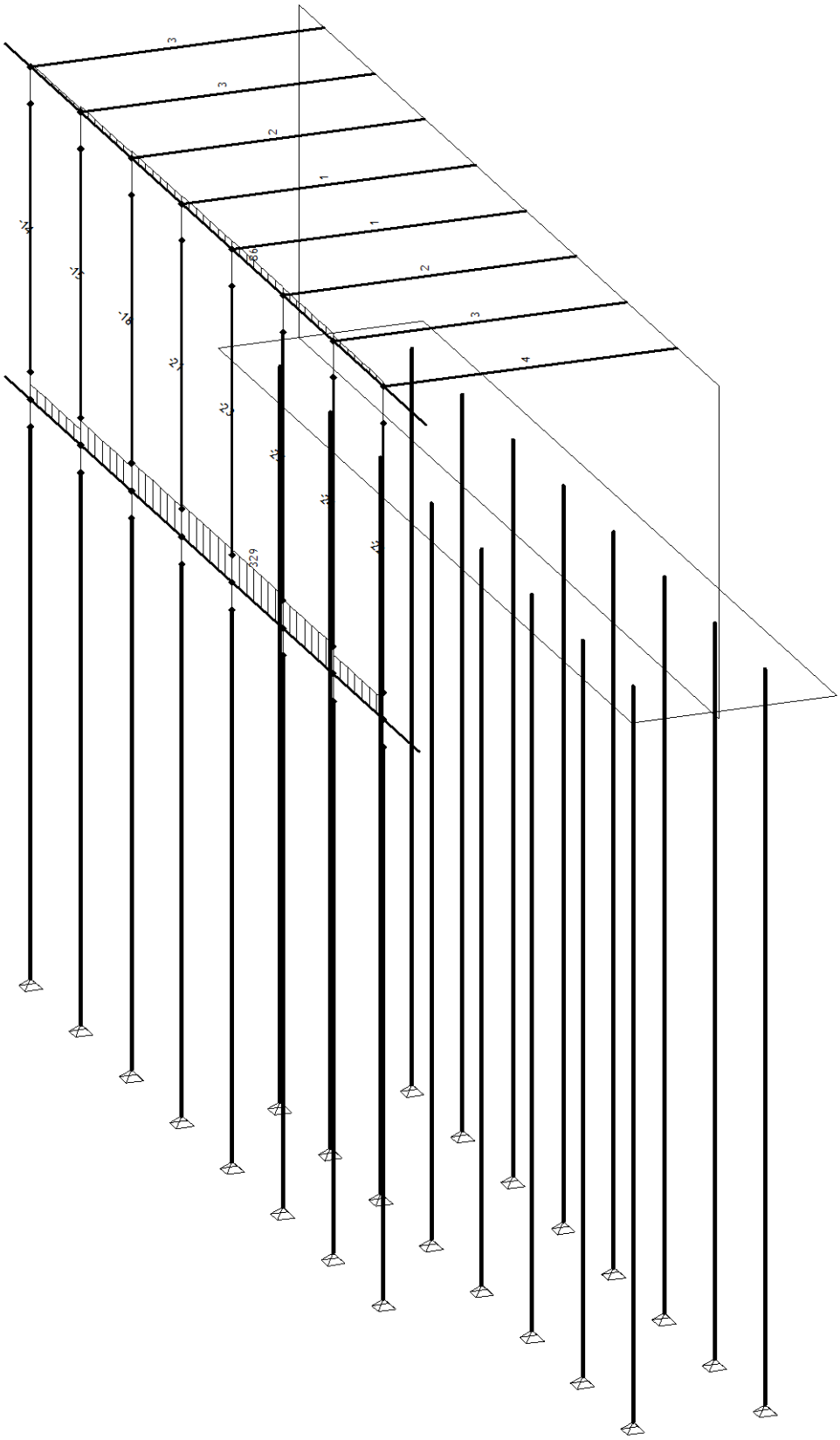
Isometric
Beam Results: max M3= 155 / min M3= -159 kNm

Load 3: Voz na nasipu



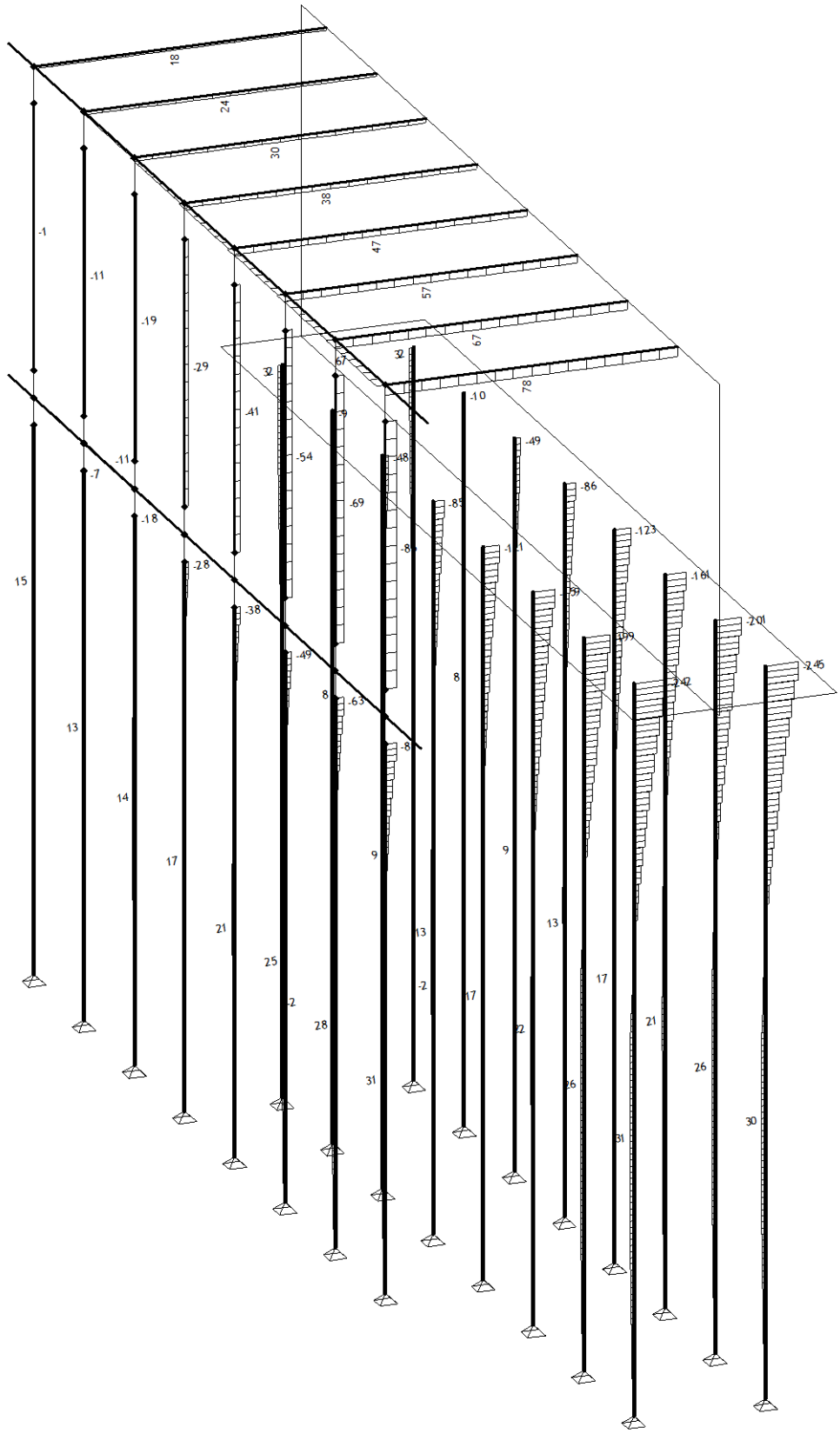
Isometric
Beam Results: max M2= 559 / min M2= -301 kNm

Load 3: Voz na nasipu



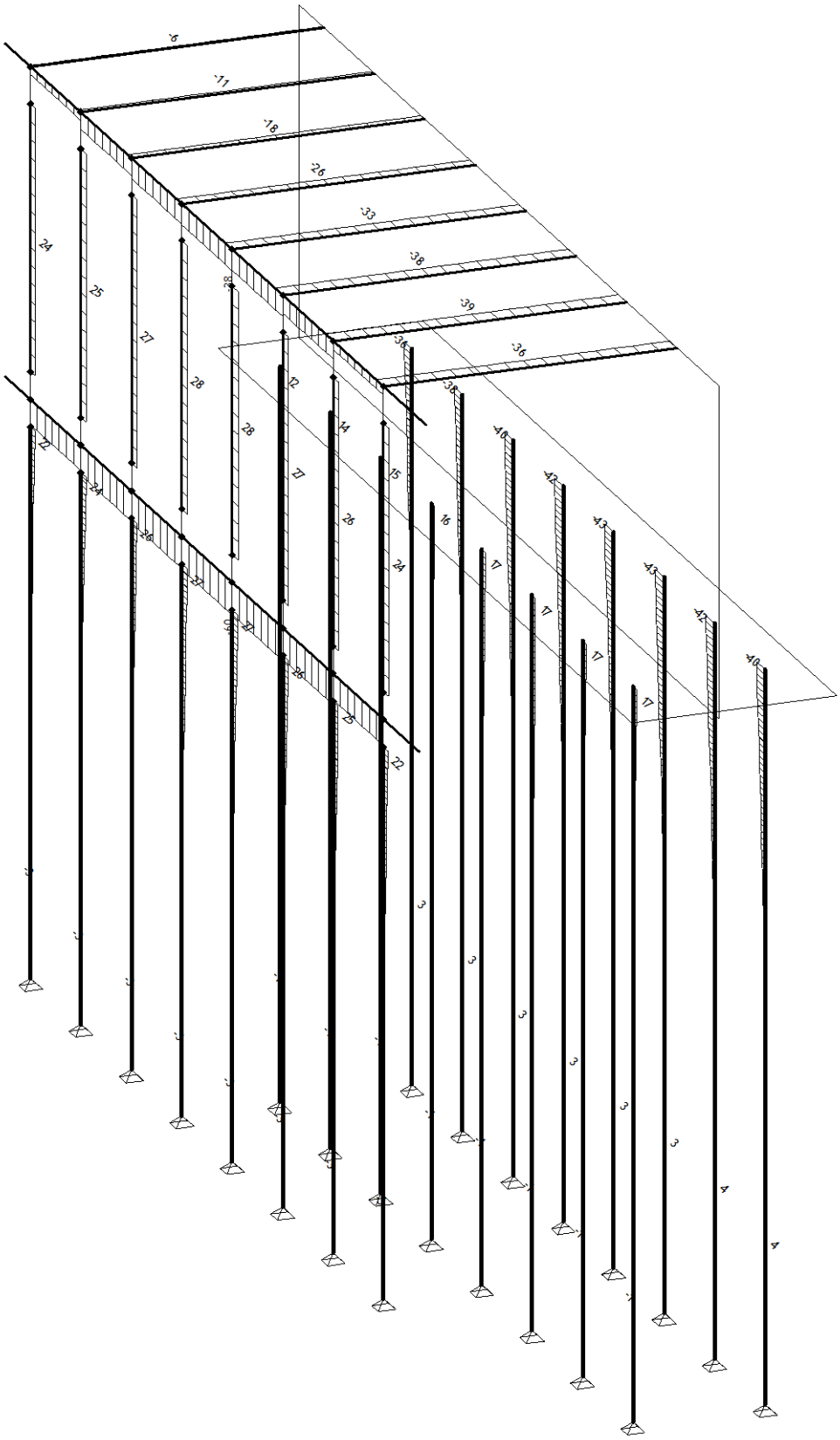
Isometric
Beam Results: max M1= 329 / min M1= -25 kNm

Load 3: Voz na nasipu



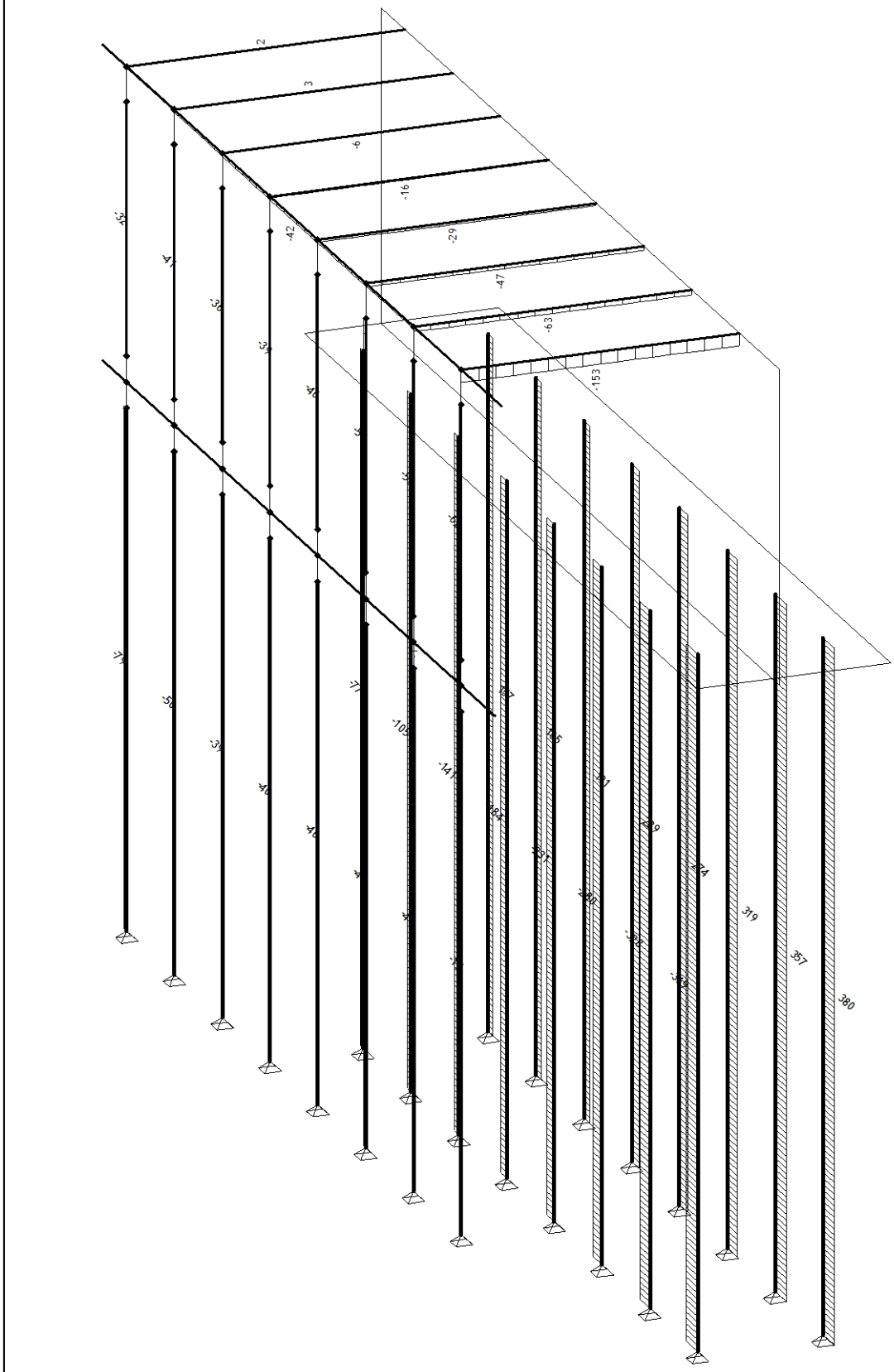
Isometric
Beam Results: max V3= 78 / min V3= -245 kN

Load 3: Voz na nasipu



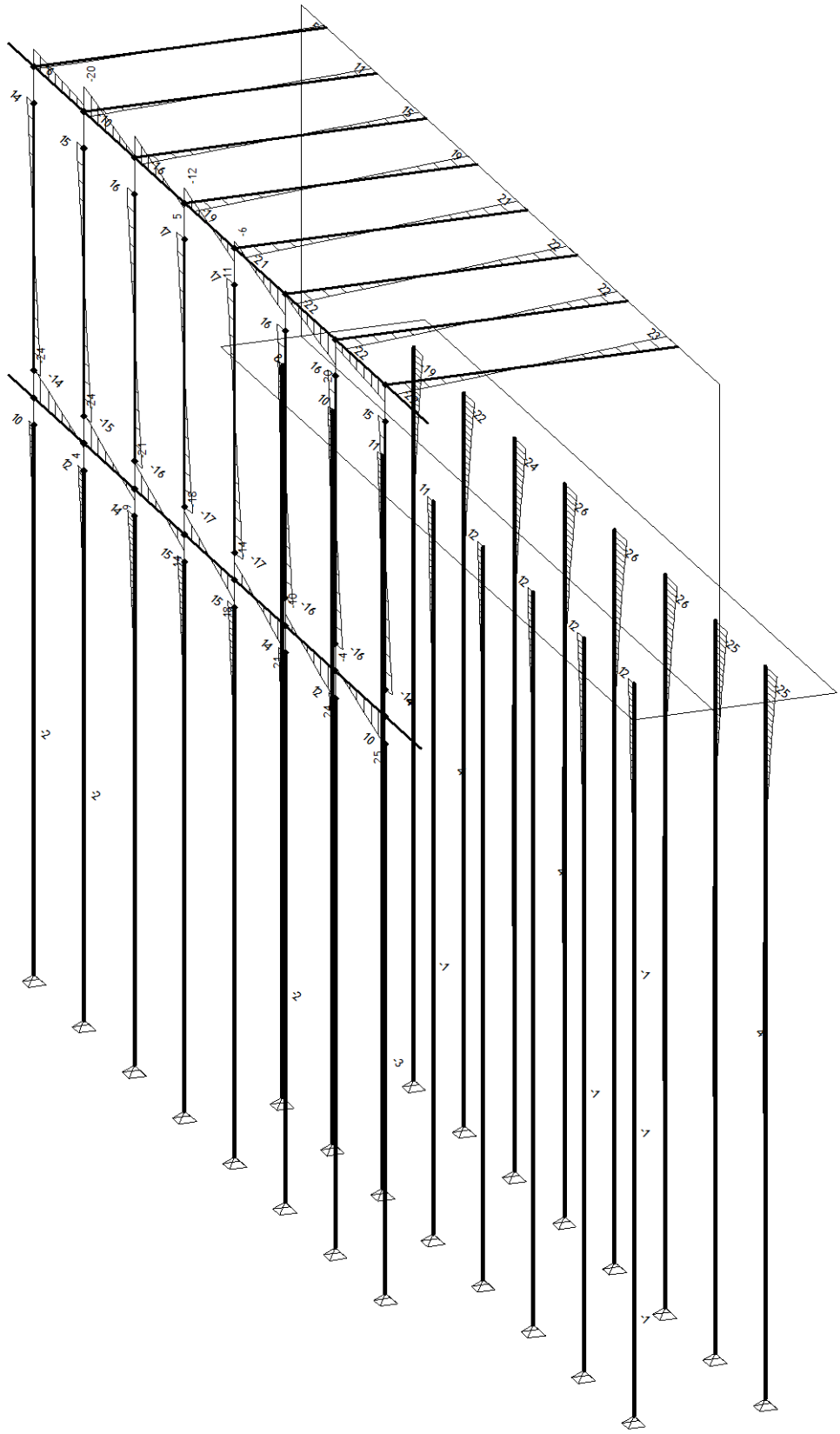
Isometric
Beam Results: max V2= 28 / min V2= -60 kN

Load 3: Voz na nasipu



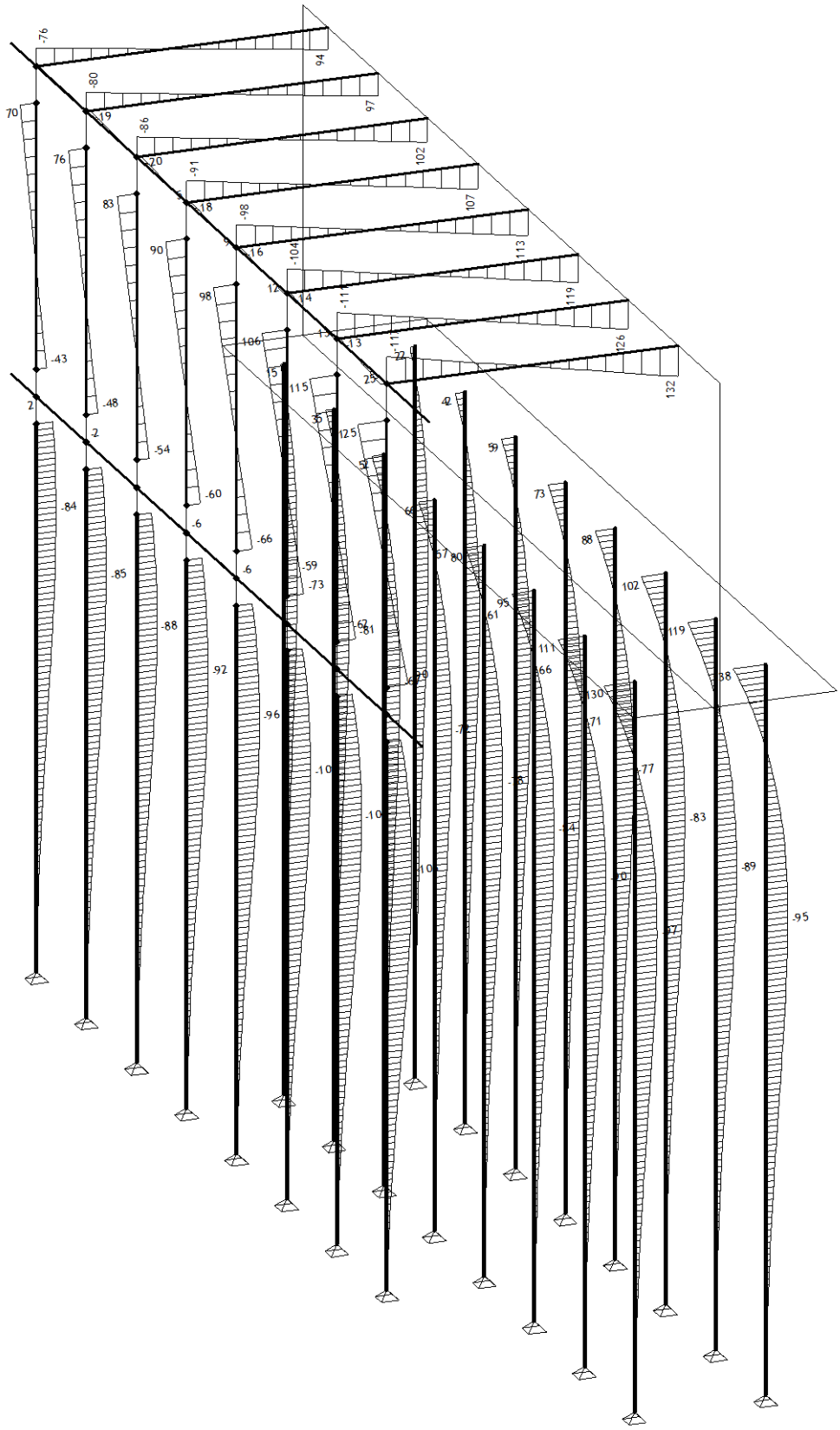
Isometric
Beam Results: max N1= 380 / min N1= -369 kN

Load 4: Seizmicki pritisak tla



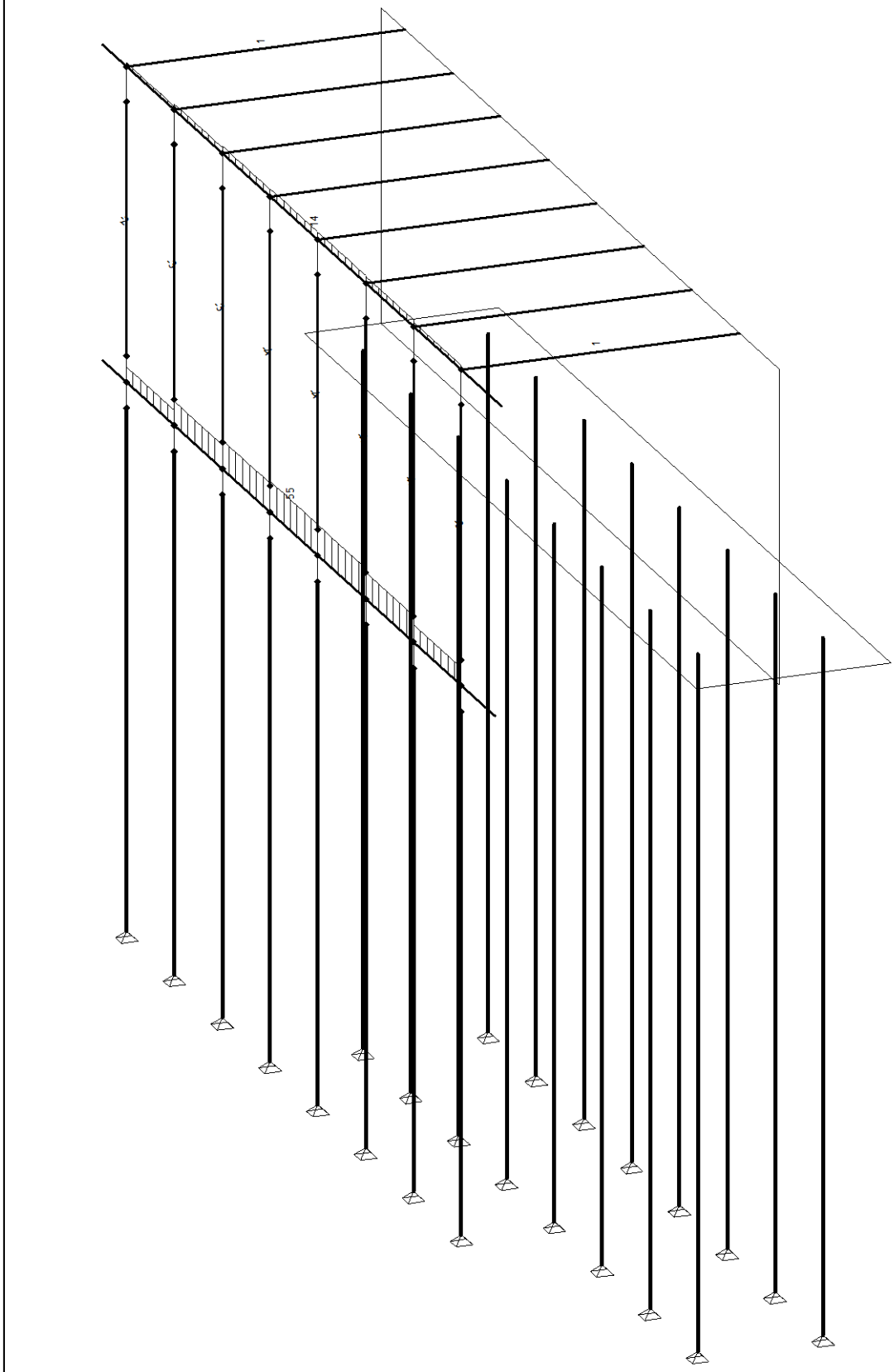
Isometric
Beam Results: max M3= 25 / min M3= -26 kNm

Load 4: Seizmicki pritisak tla



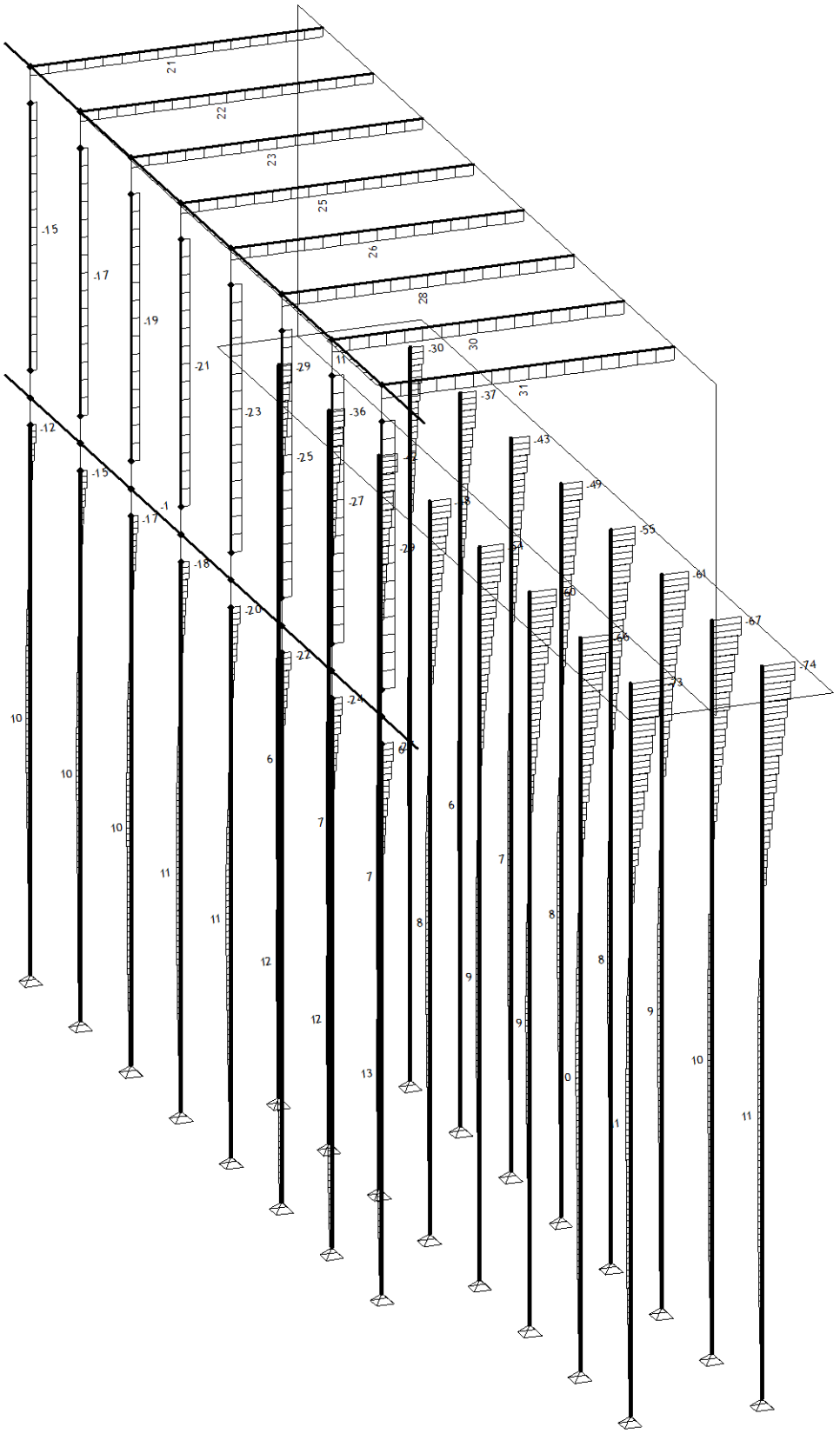
Isometric
Beam Results: max M2= 138 / min M2= -117 kNm

Load 4: Seizmicki pritisak tla



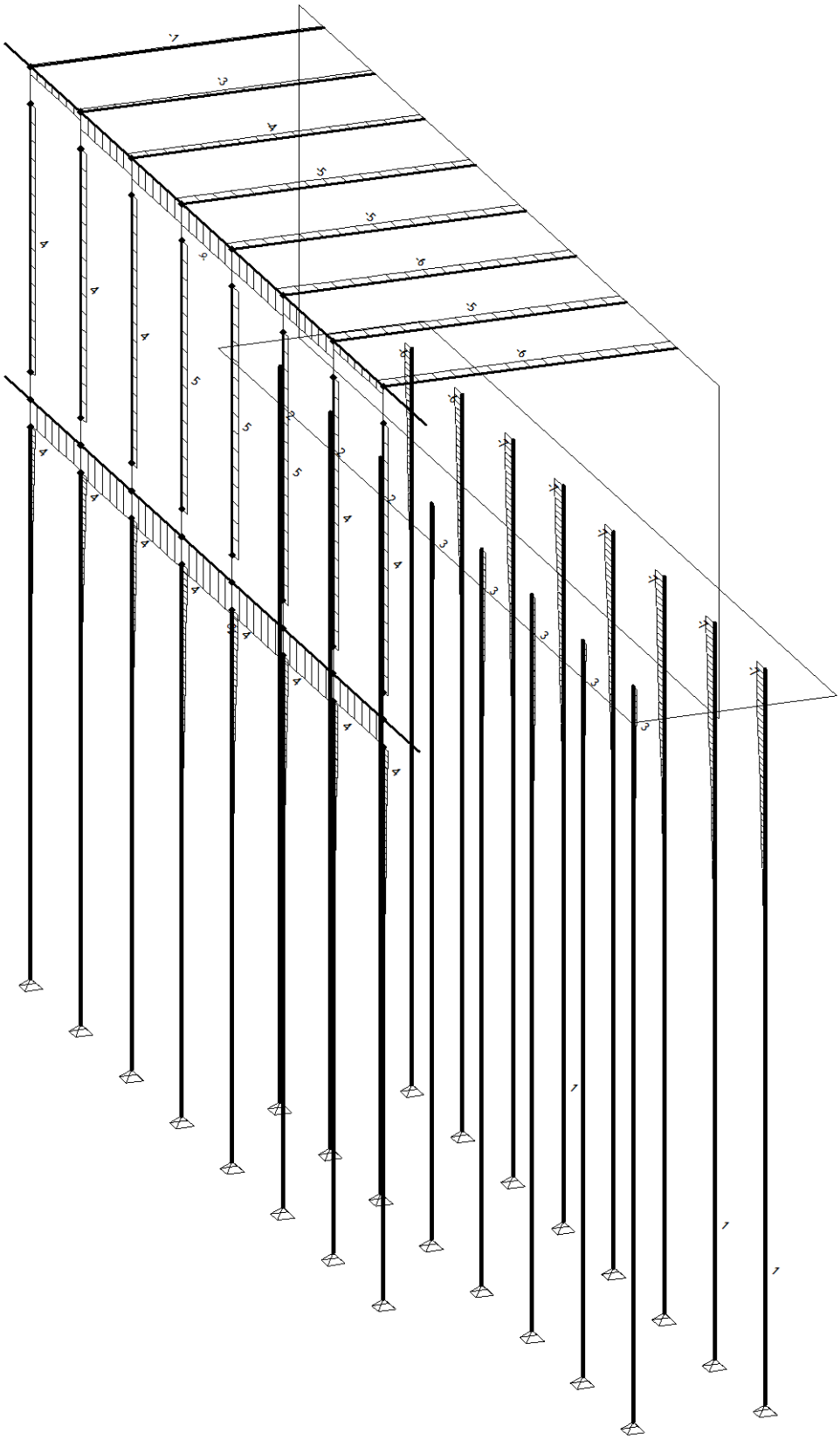
Isometric
Beam Results: max M1= 55 / min M1= -4 kNm

Load 4: Seizmicki pritisak tla



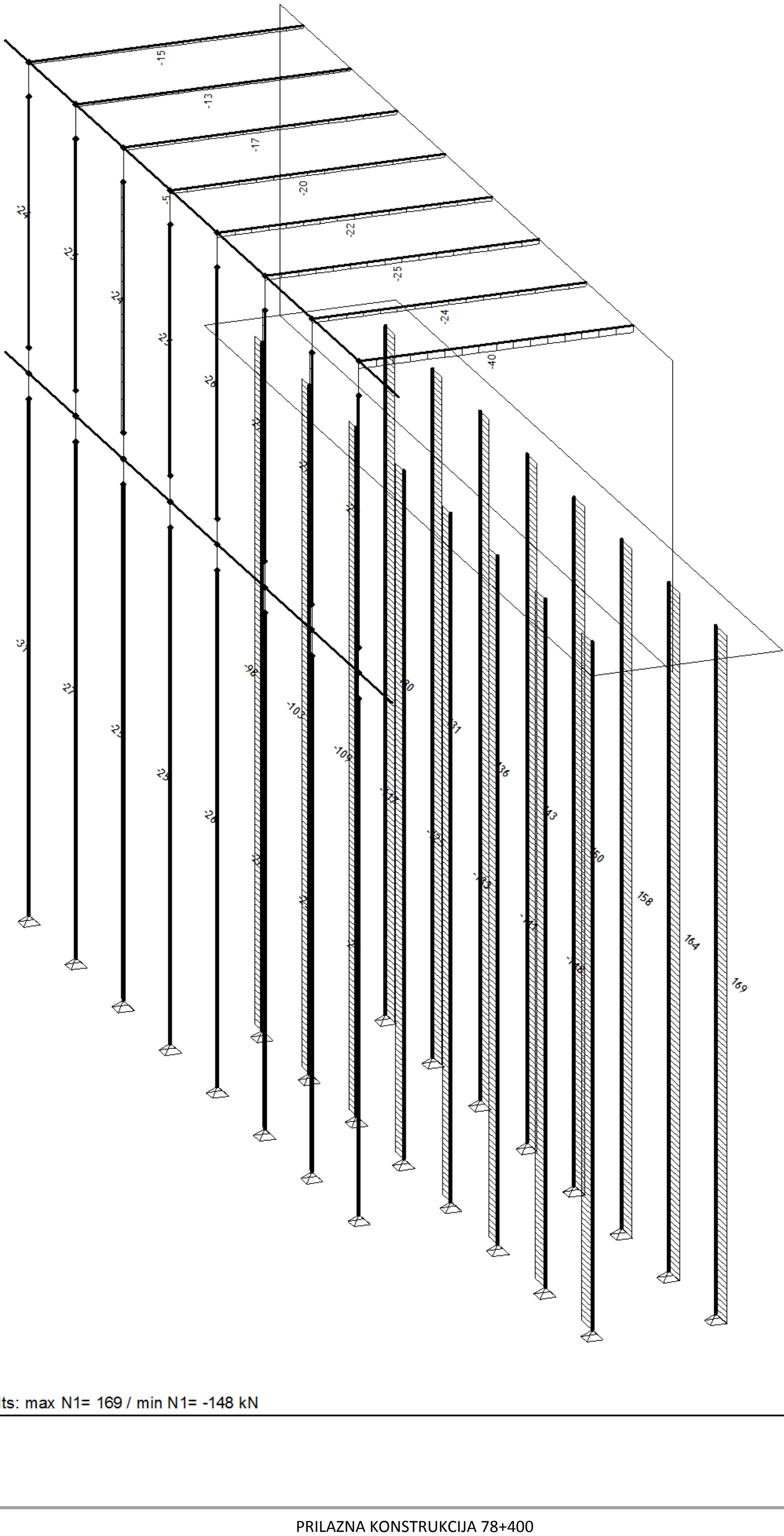
Isometric
Beam Results: max V3= 31 / min V3= -74 kN

Load 4: Seizmicki pritisak tla



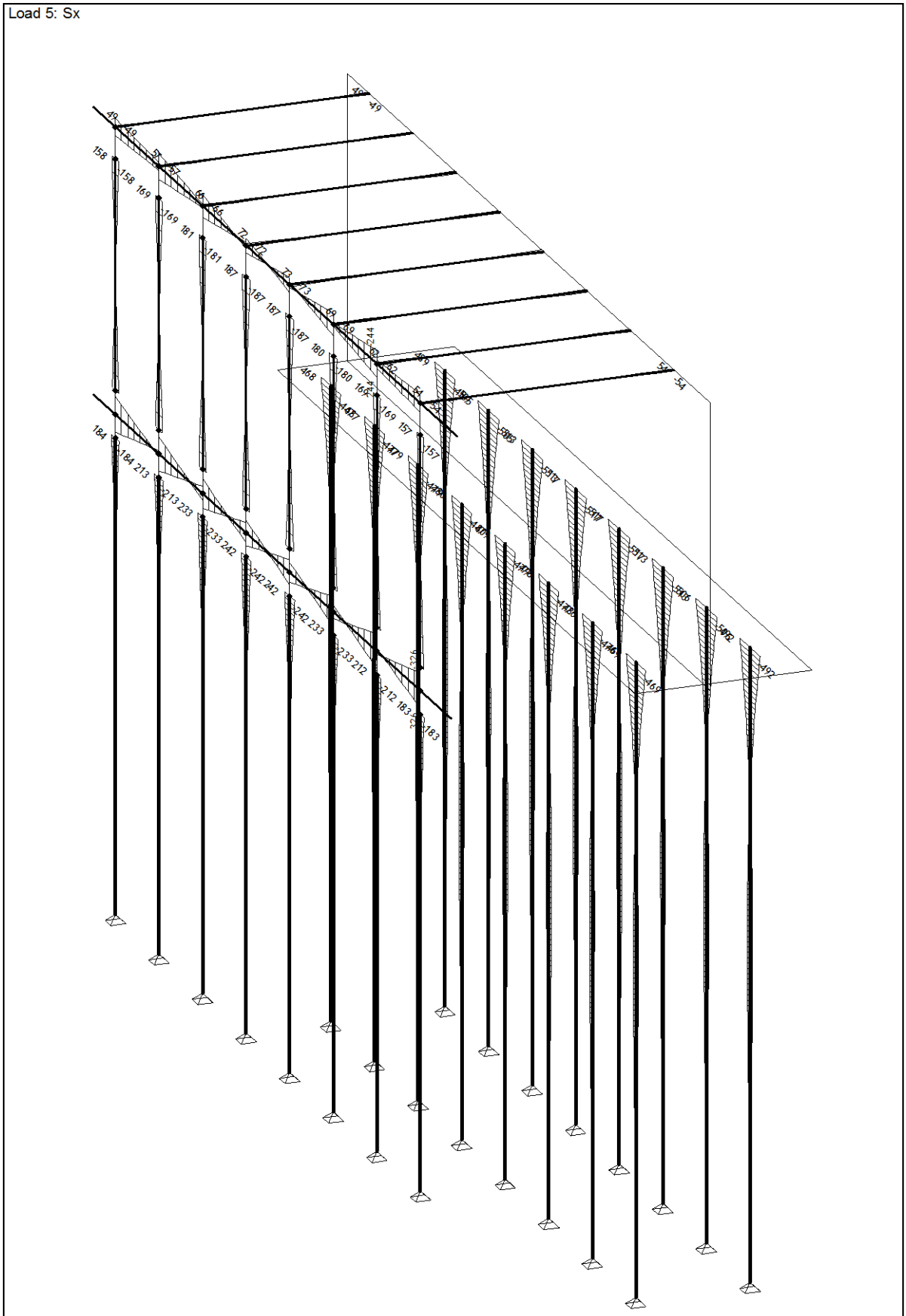
Isometric
Beam Results: max V2= 5 / min V2= -10 kN

Load 4: Seizmicki pritisak tla



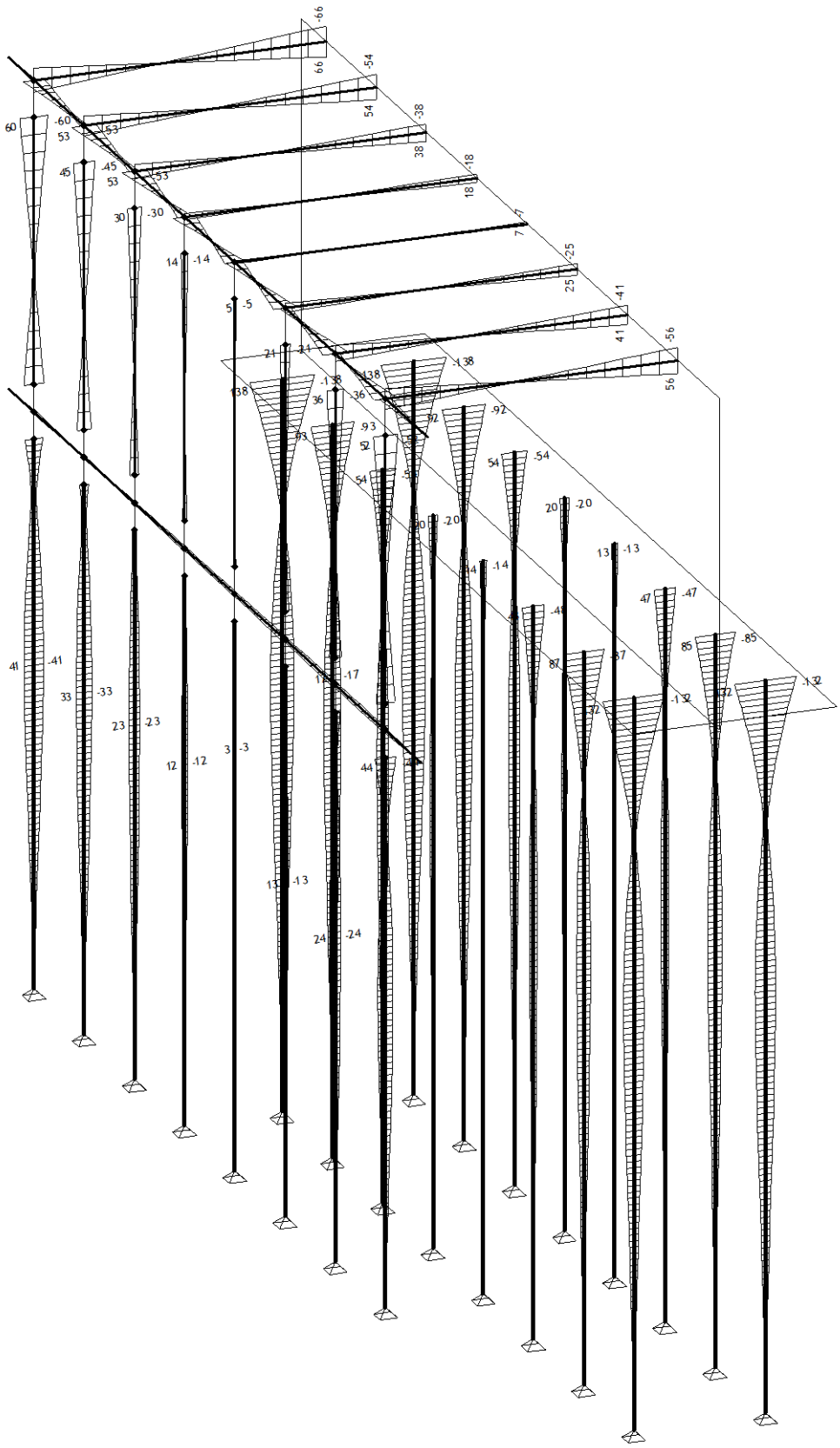
Isometric
Beam Results: max N1= 169 / min N1= -148 kN

Load 5: Sx



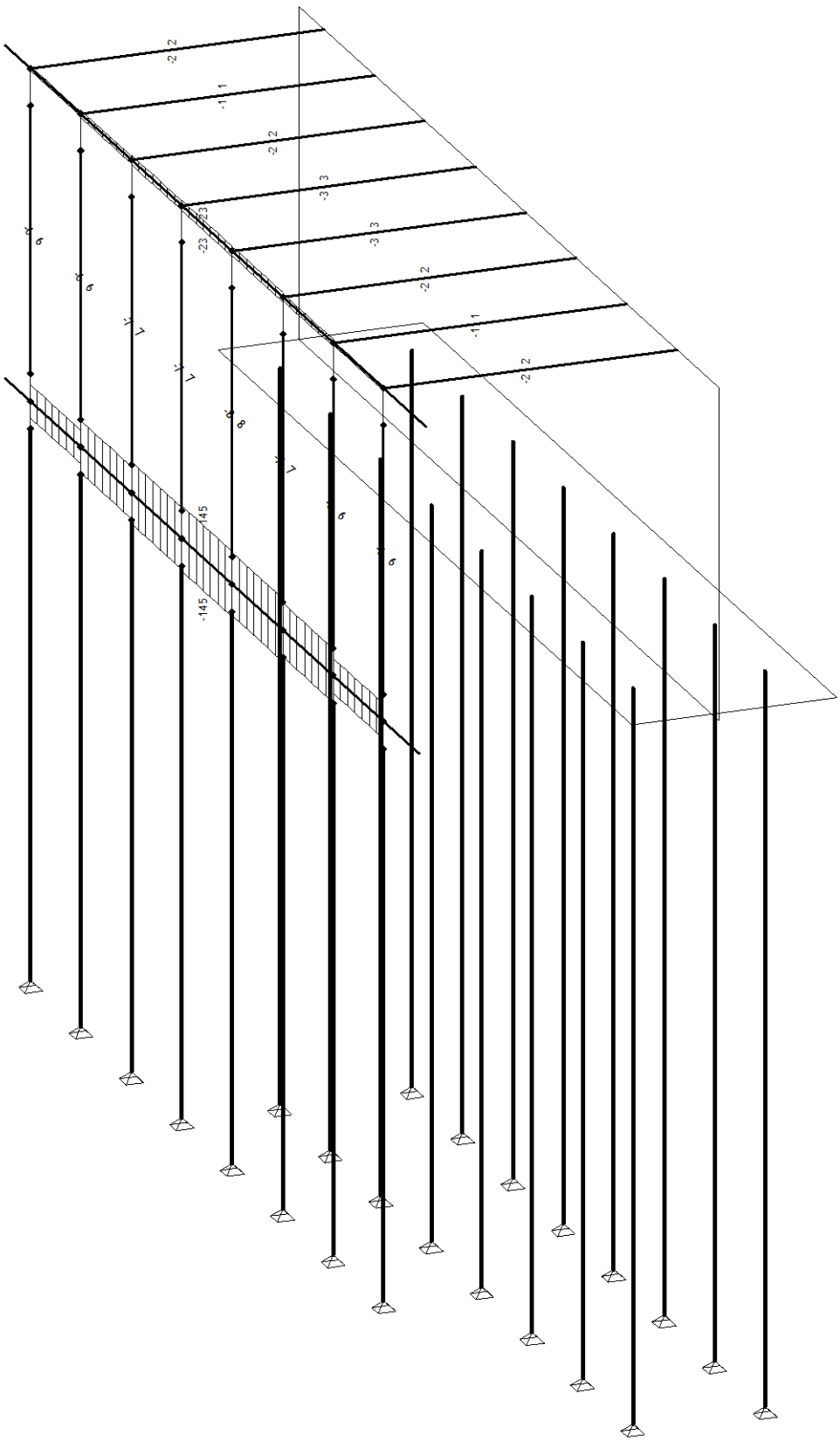
Isometric
Beam Results: max M3= 517 / min M3= -517 kNm

Load 5: Sx



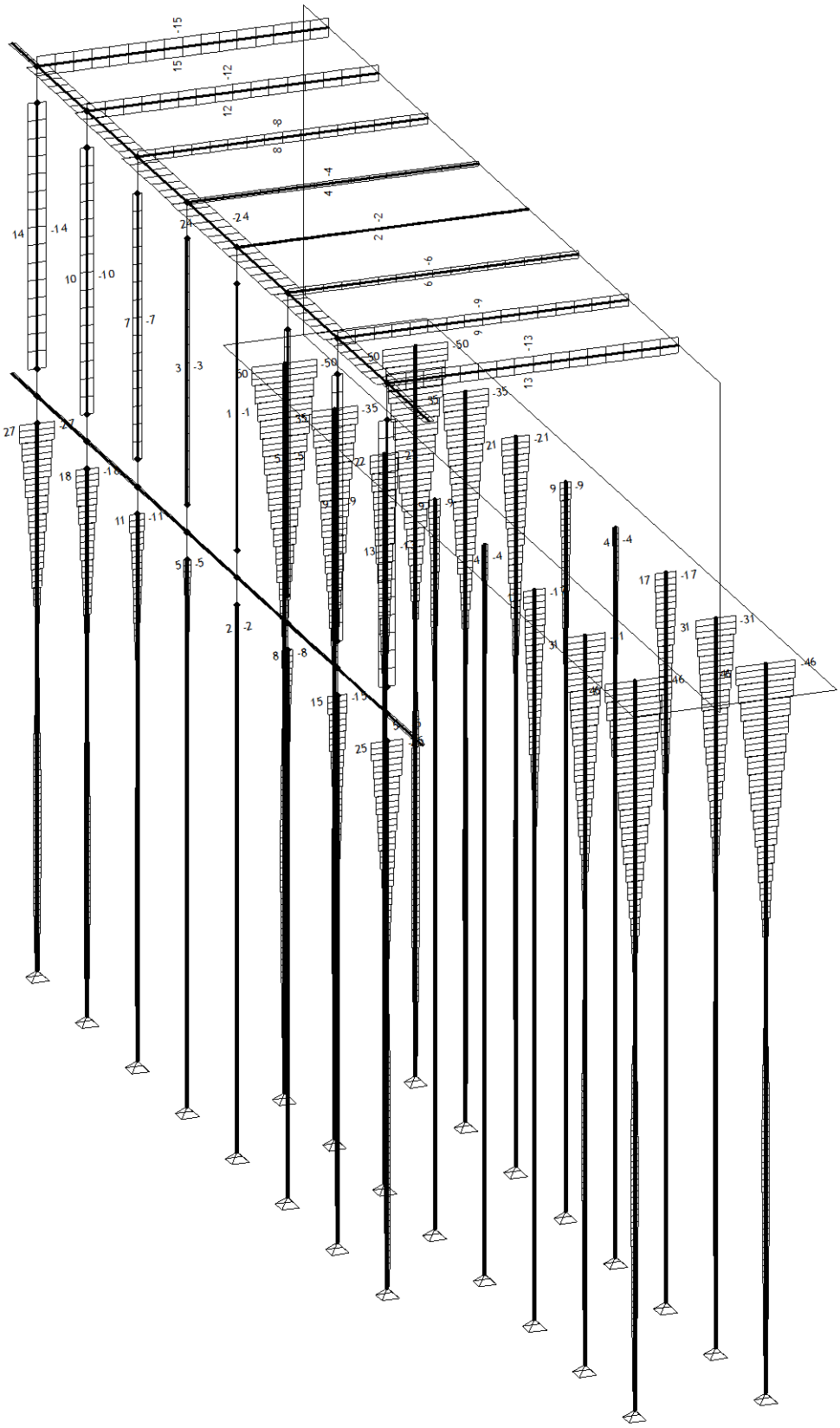
Isometric
Beam Results: max M2= 138 / min M2= -138 kNm

Load 5: Sx



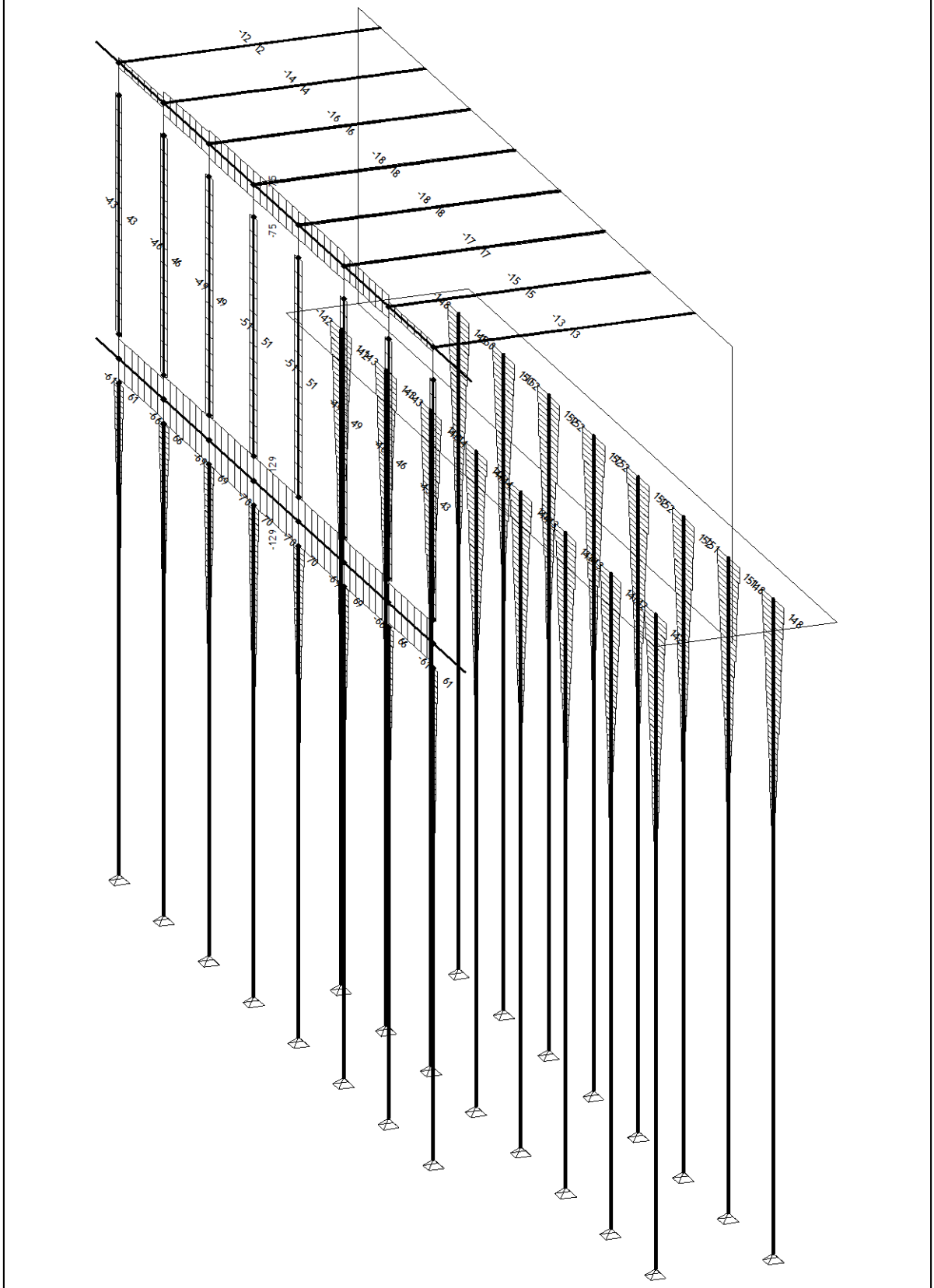
Isometric
Beam Results: max M1= 145 / min M1= -145 kNm

Load 5: Sx



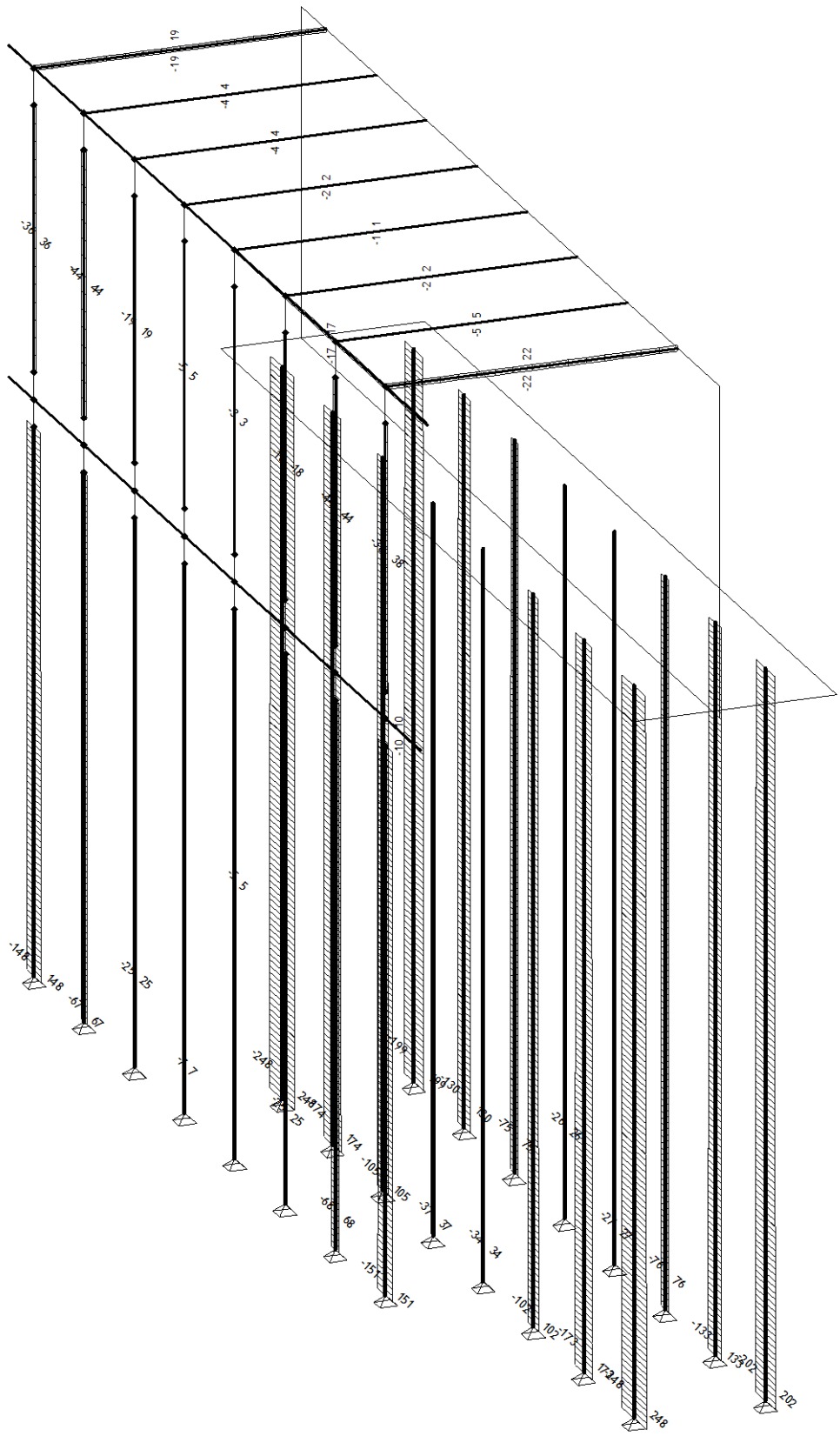
Isometric
Beam Results: max V3= 50 / min V3= -50 kN

Load 5: Sx



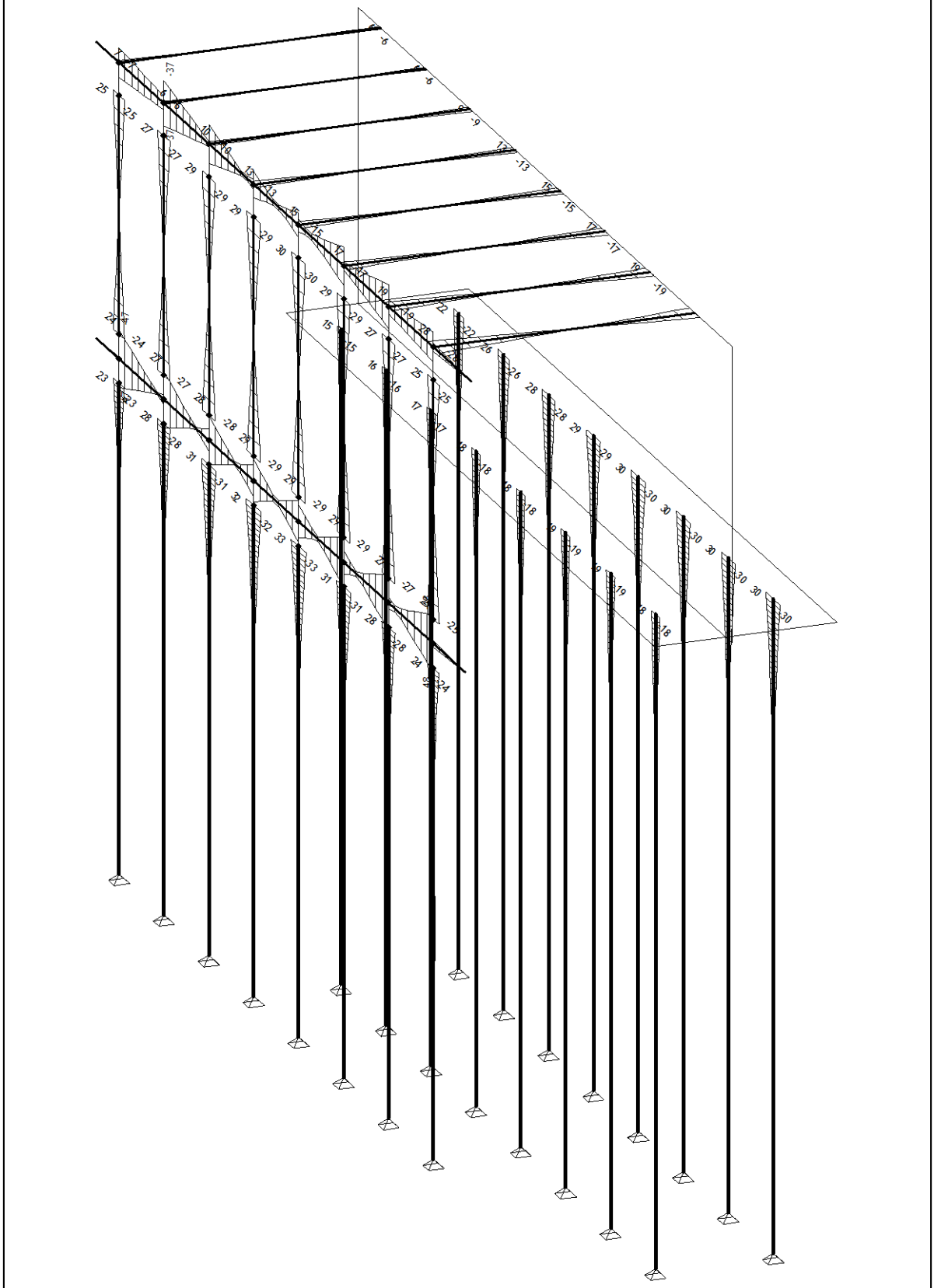
Isometric
Beam Results: max V2= 152 / min V2= -152 kN

Load 5: Sx



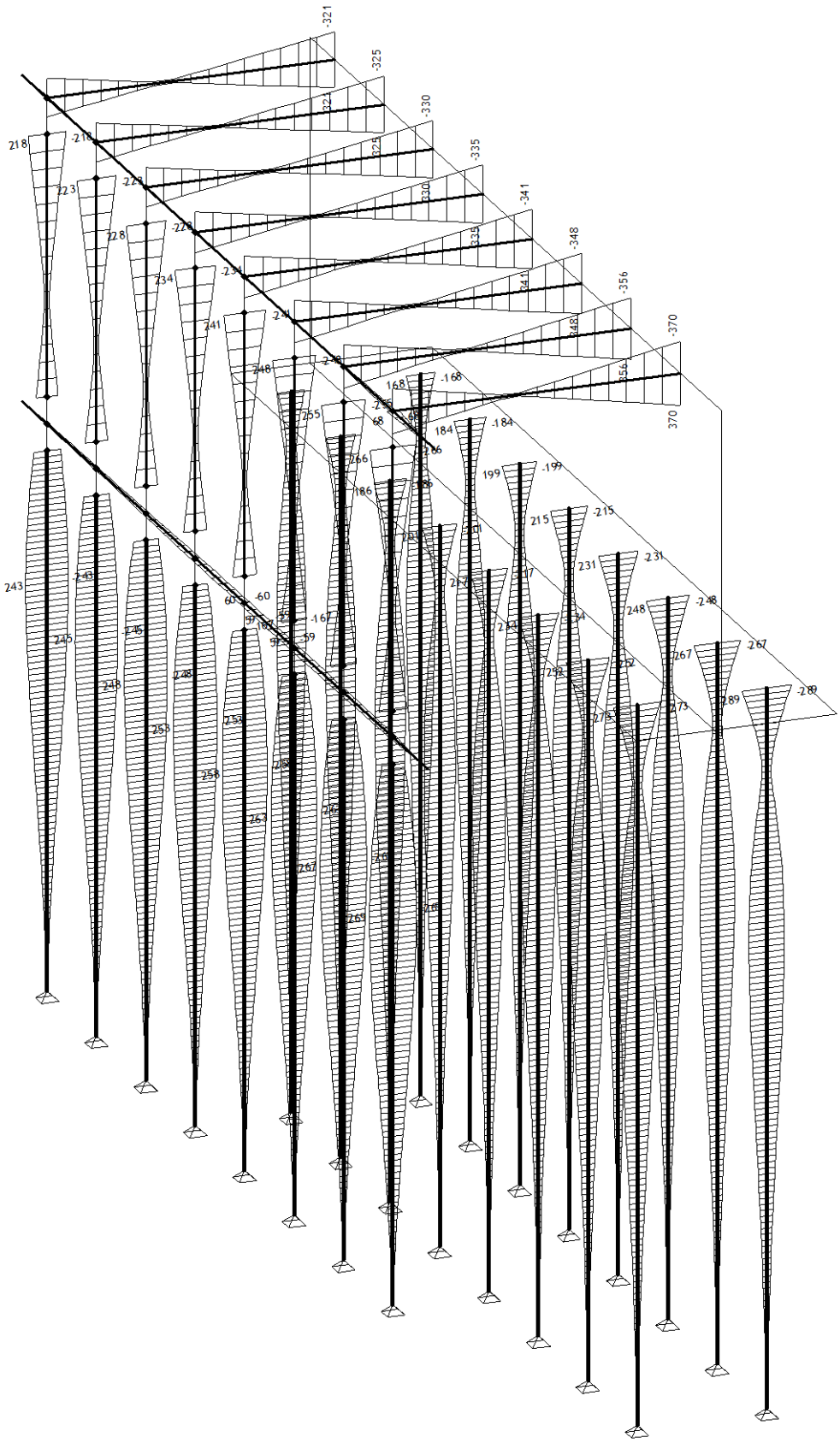
Isometric
Beam Results: max N1= 248 / min N1= -248 kN

Load 6: Sy



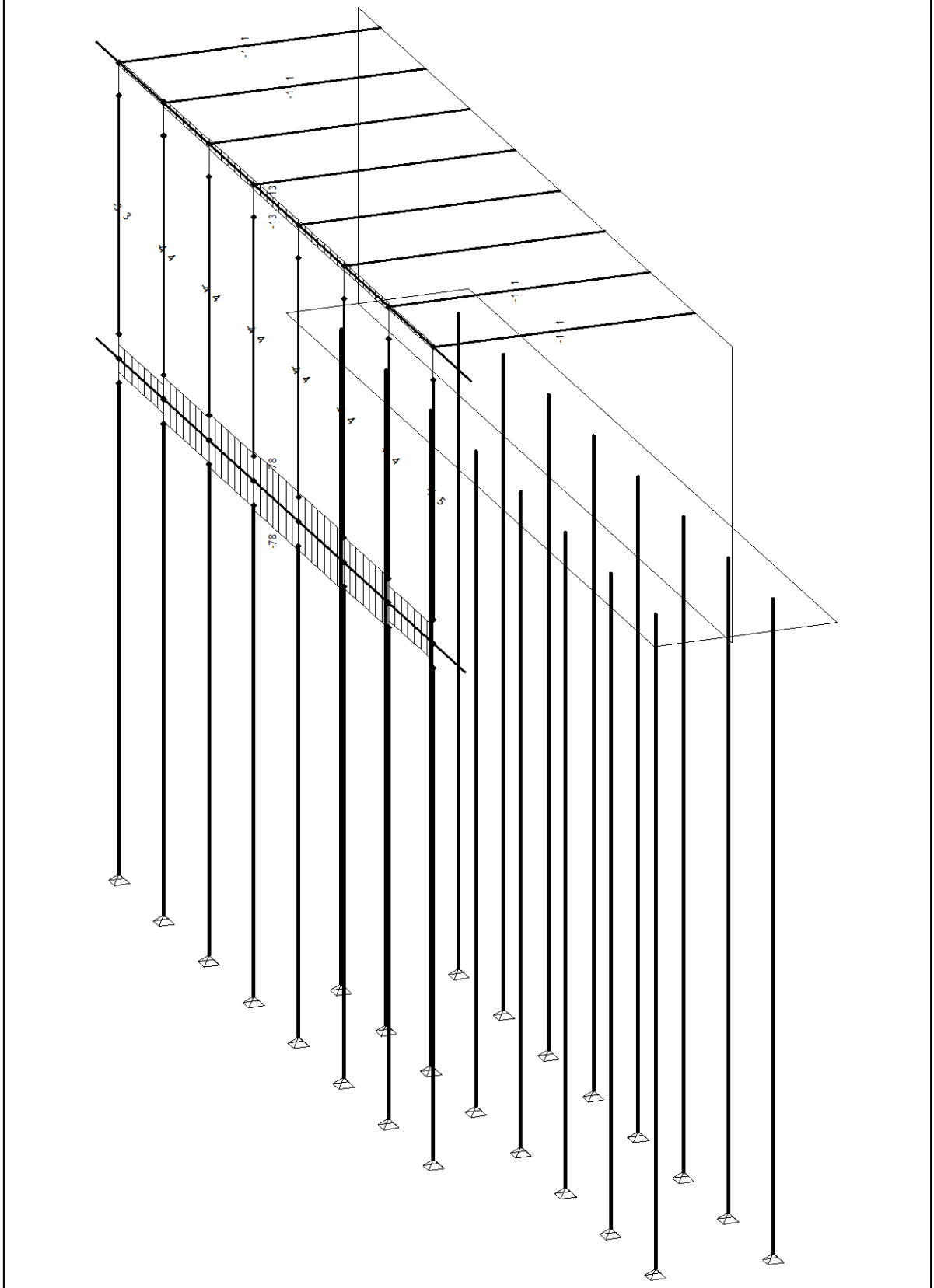
Isometric
Beam Results: max M3= 48 / min M3= -48 kNm

Load 6: Sy



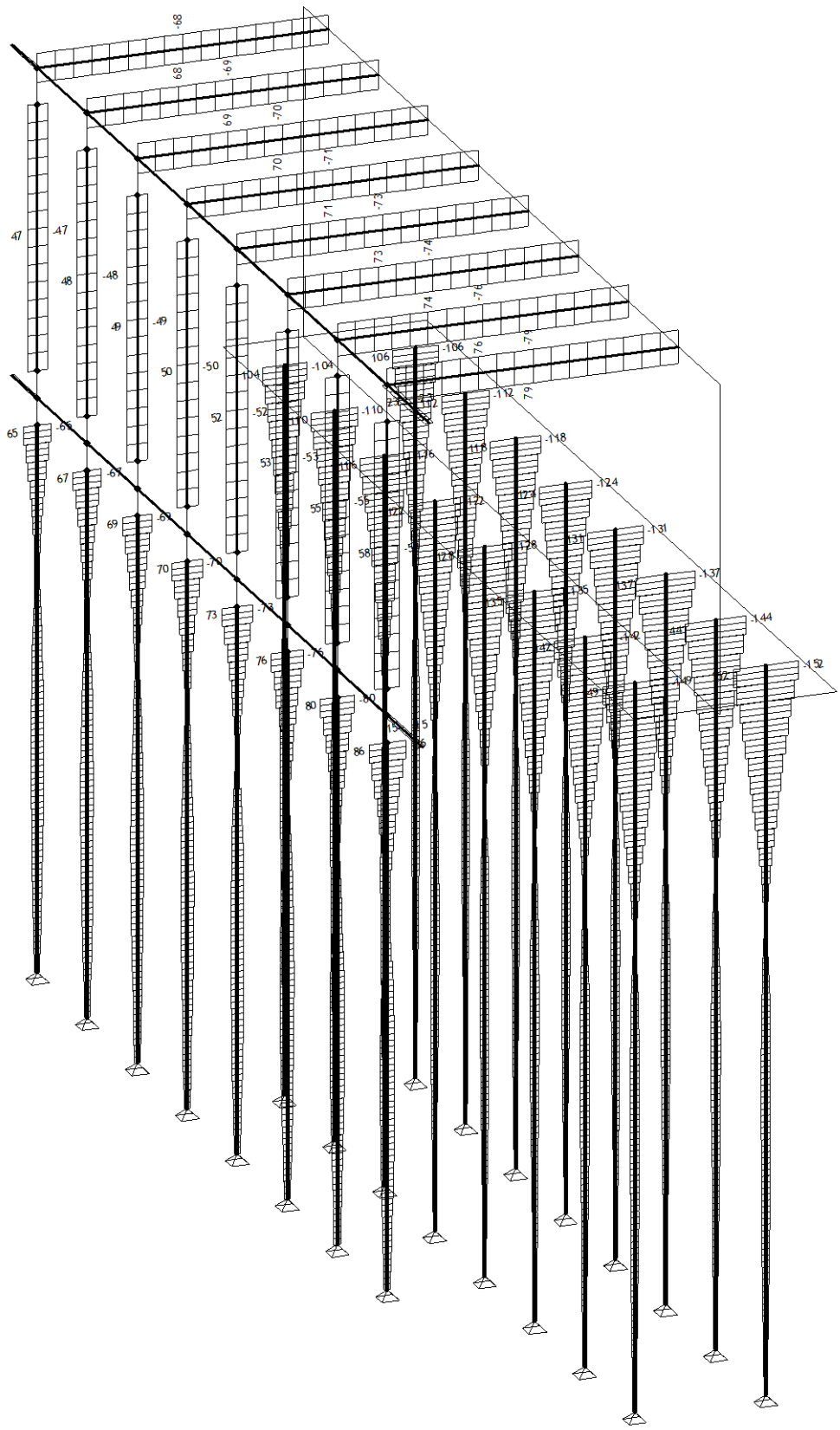
Isometric
Beam Results: max M2= 370 / min M2= -370 kNm

Load 6: Sy



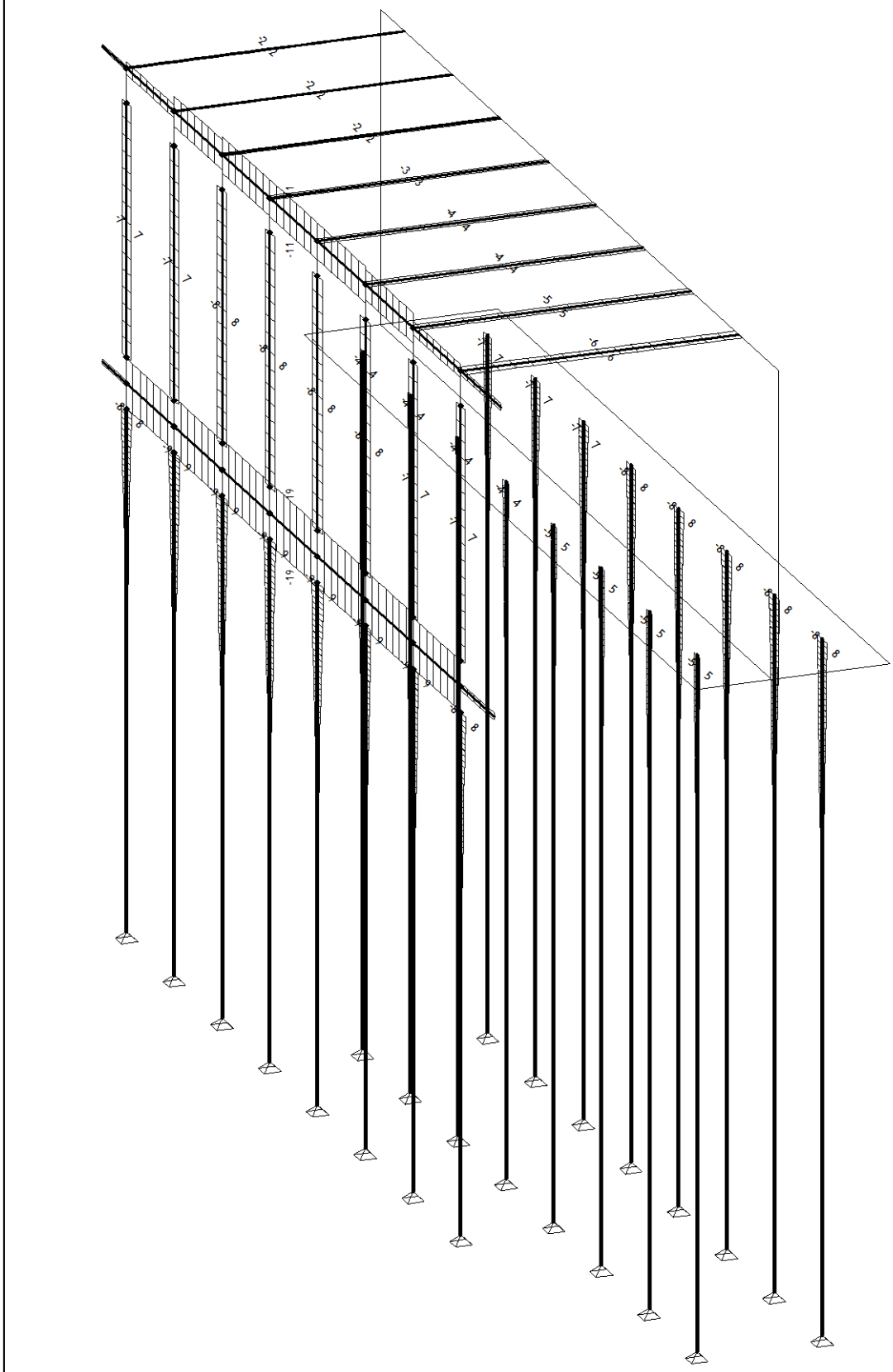
Isometric
Beam Results: max M1= 78 / min M1= -78 kNm

Load 6: Sy



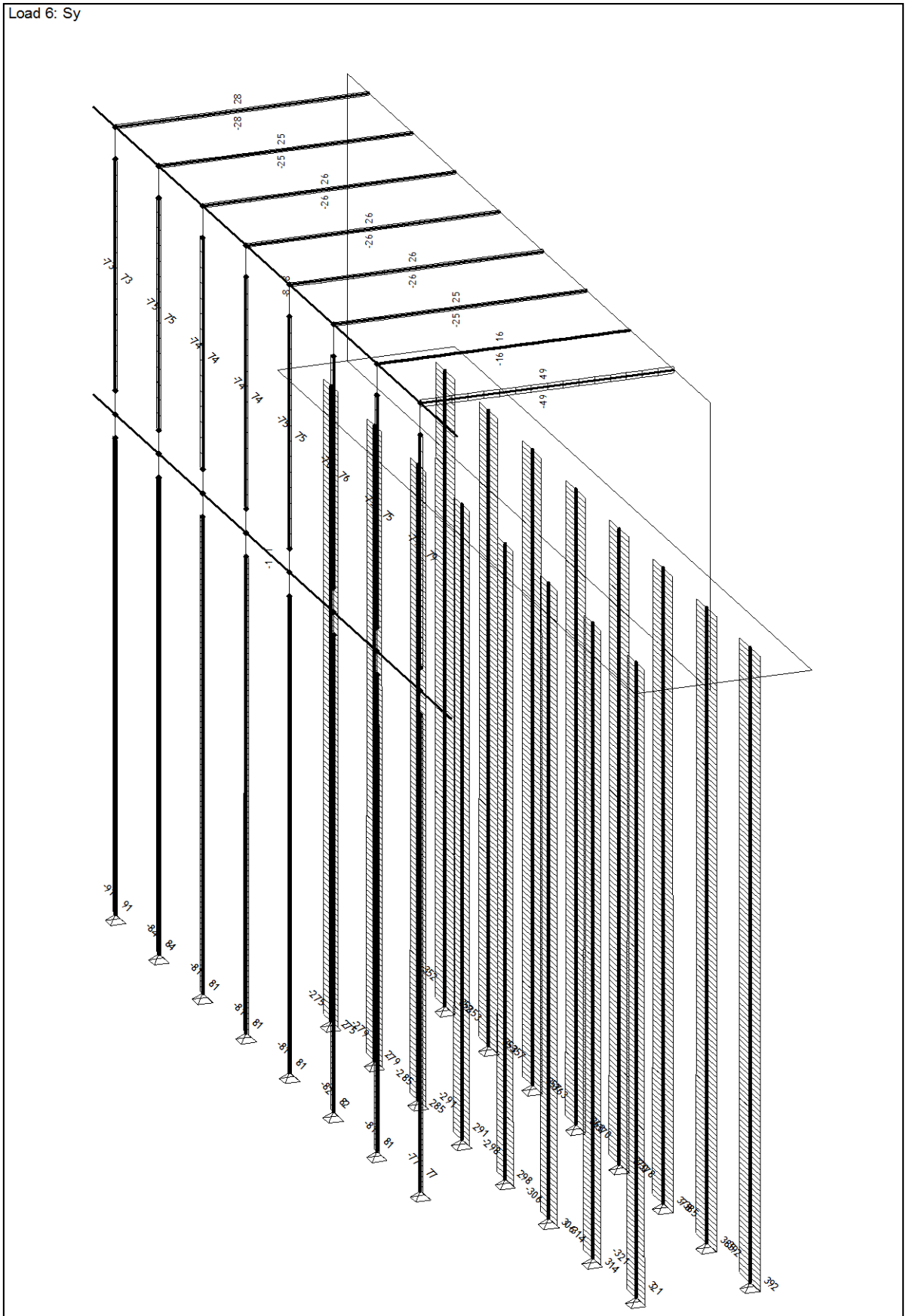
Isometric
Beam Results: max V3= 152 / min V3= -152 kN

Load 6: Sy



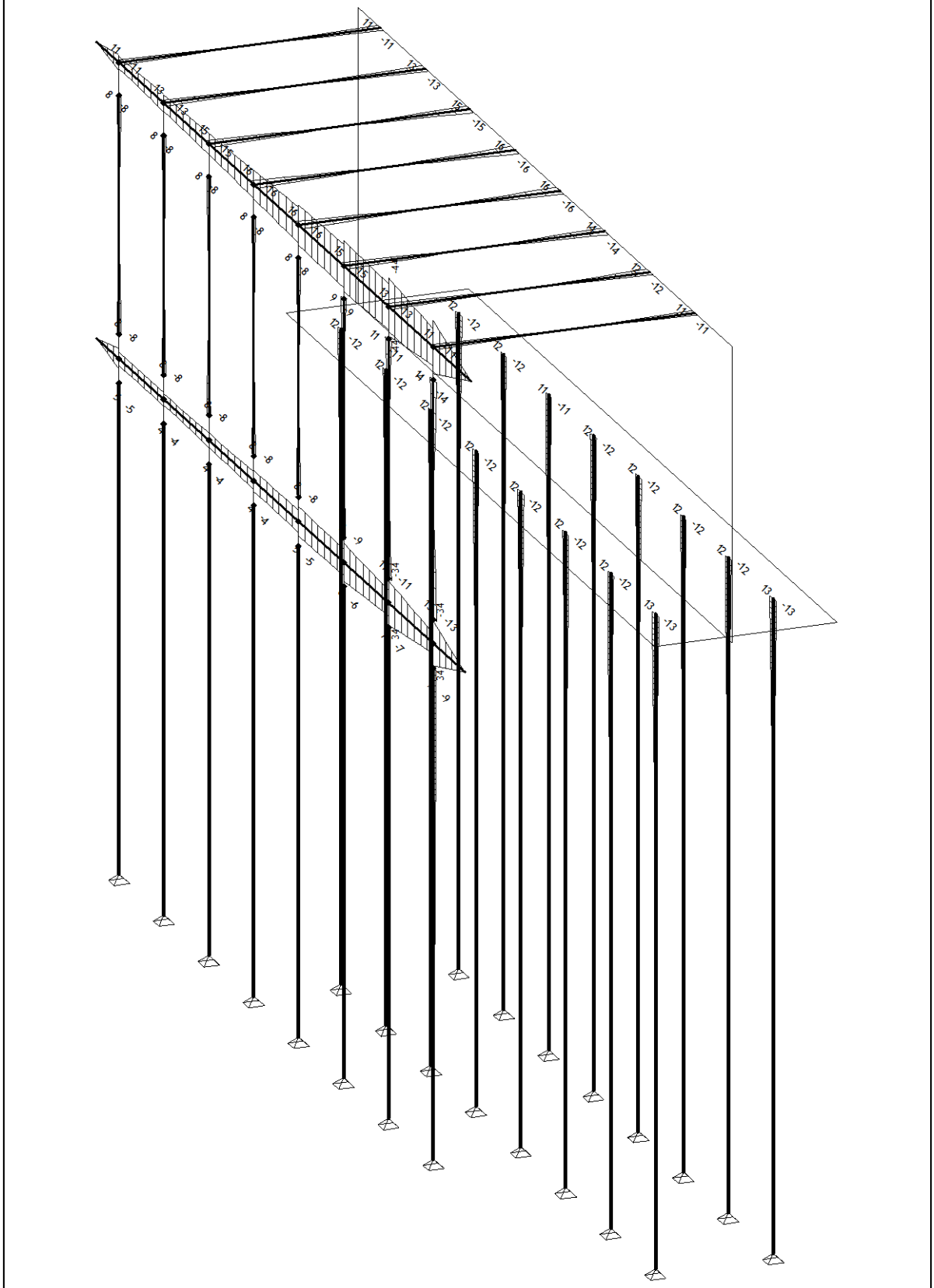
Isometric
Beam Results: max V2= 19 / min V2= -19 kN

Load 6: Sy



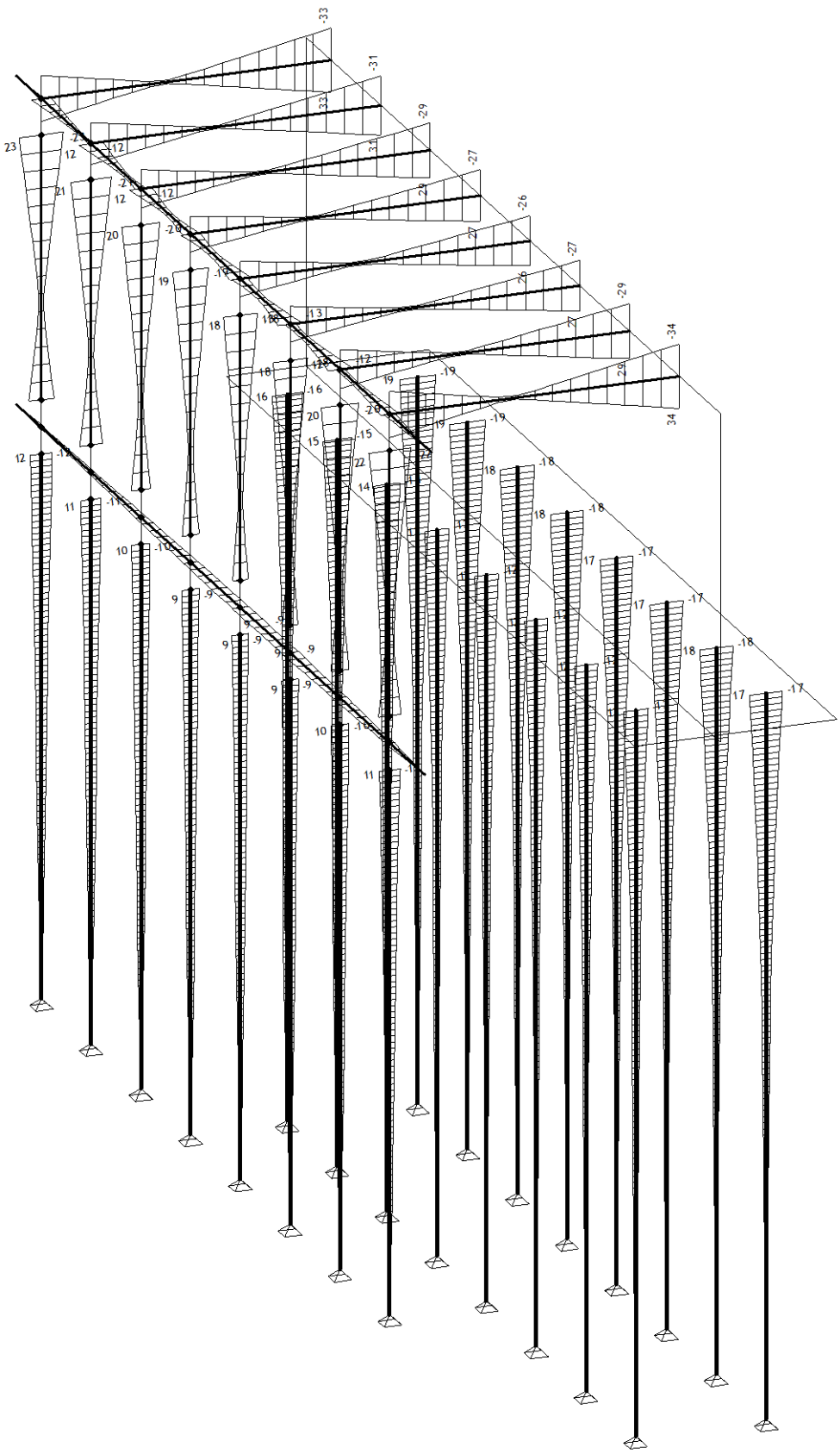
Isometric
Beam Results: max N1= 393 / min N1= -393 kN

Load 7: Sz



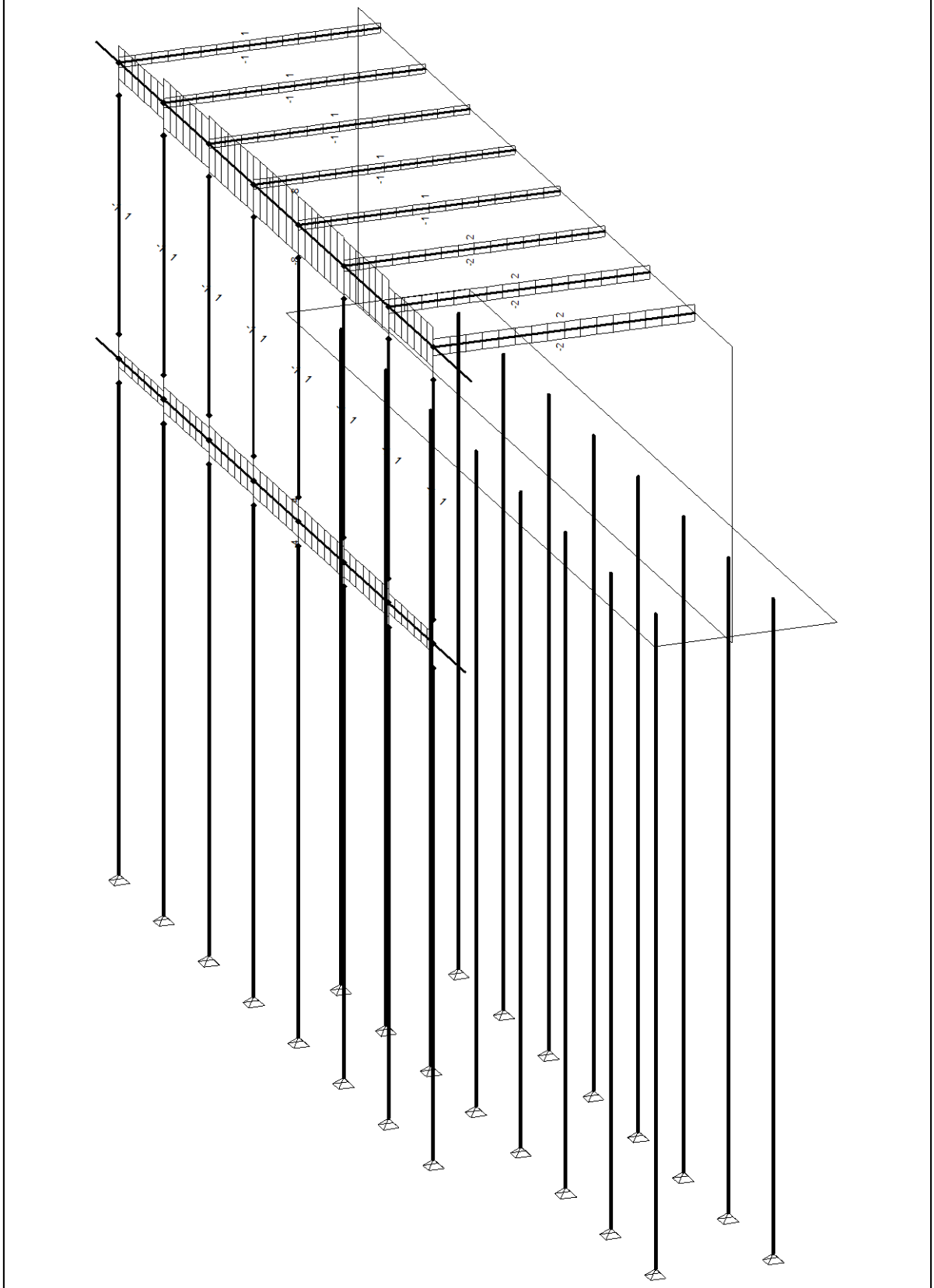
Isometric
Beam Results: max M3= 44 / min M3= -44 kNm

Load 7: Sz



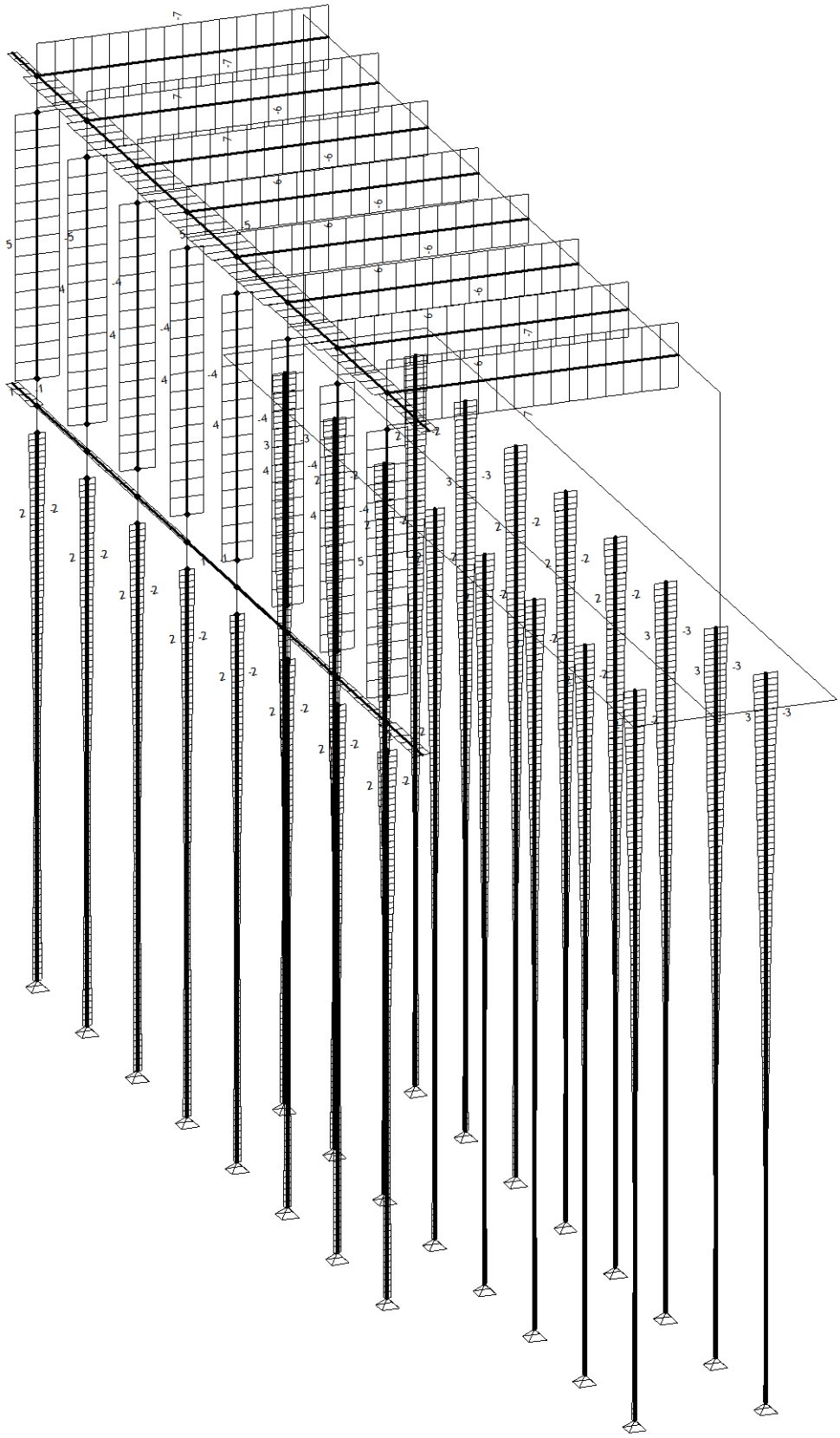
Isometric
Beam Results: max M2= 34 / min M2= -34 kNm

Load 7: Sz



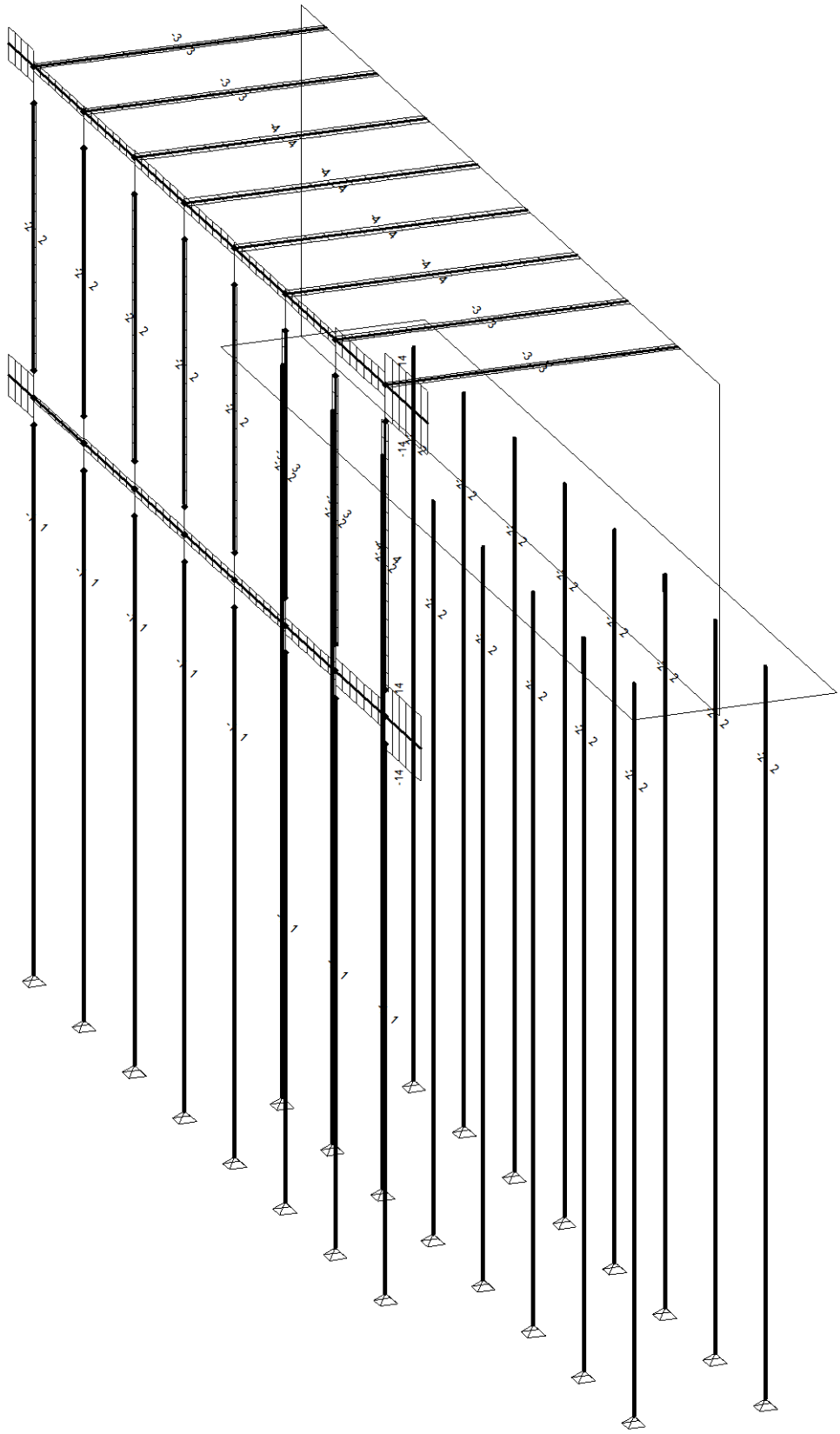
Isometric
Beam Results: max M1= 8 / min M1= -8 kNm

Load 7: Sz



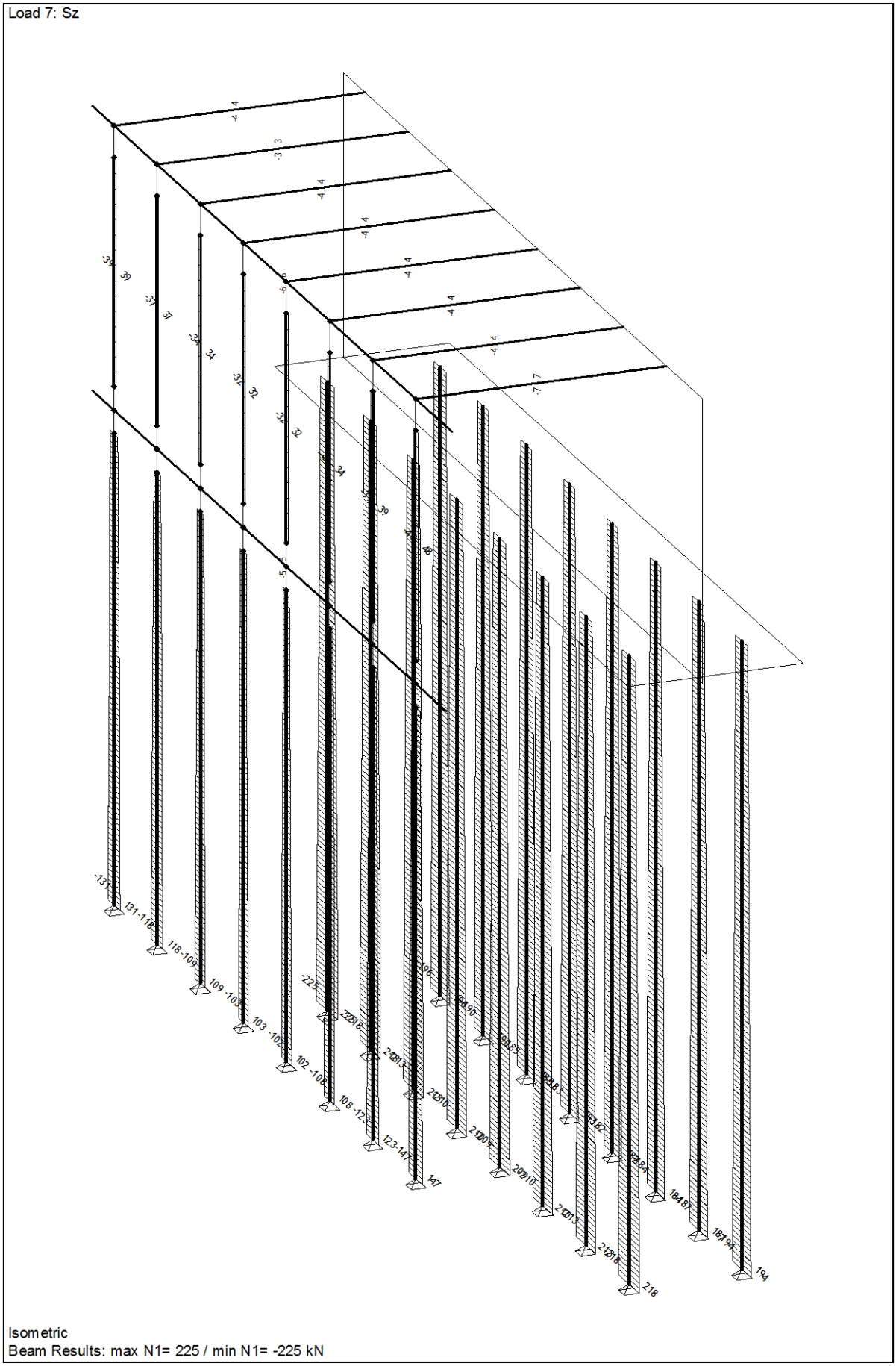
Isometric
Beam Results: max V3= 7 / min V3= -7 kN

Load 7: Sz

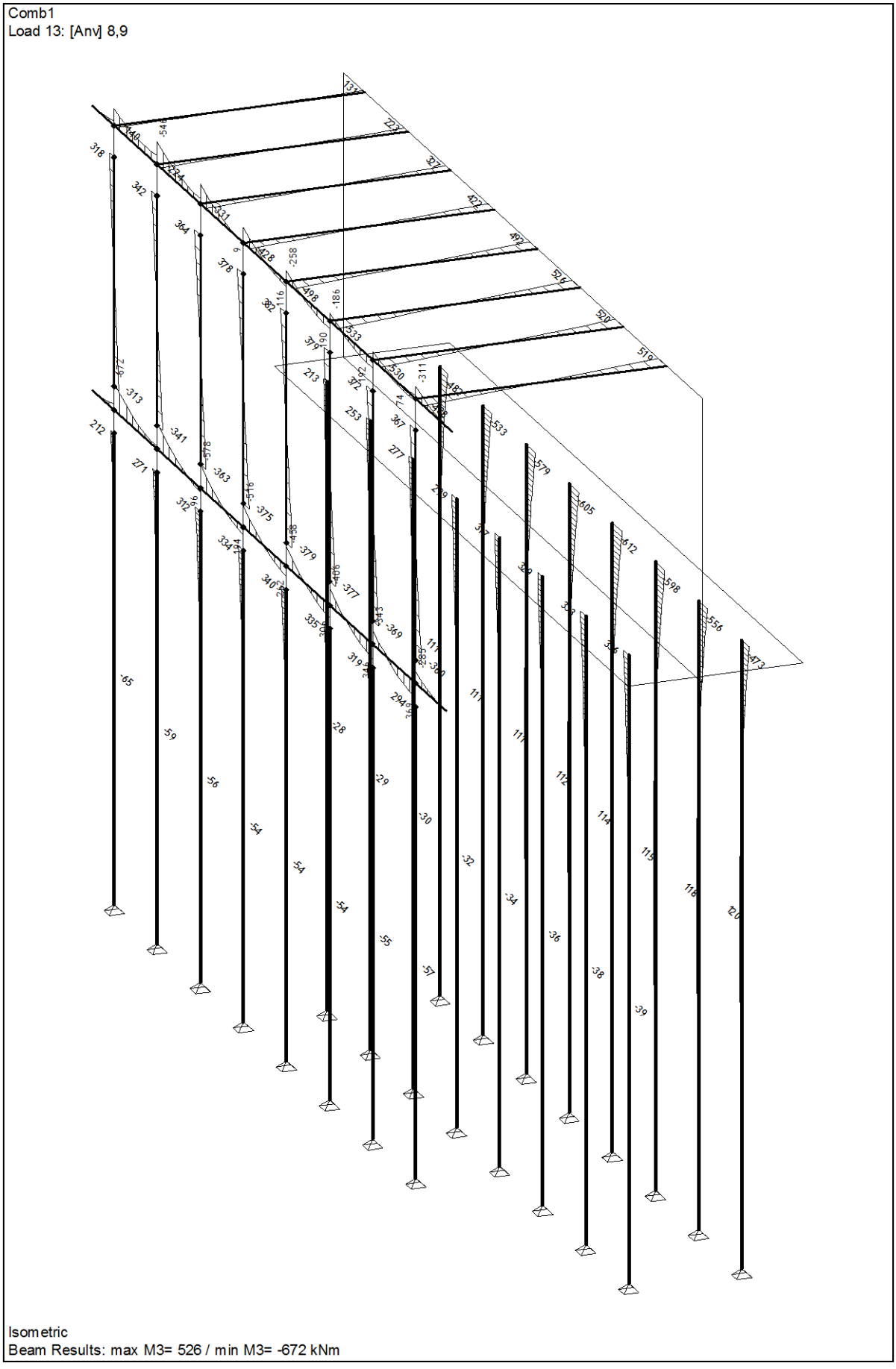


Isometric
Beam Results: max V2= 14 / min V2= -14 kN

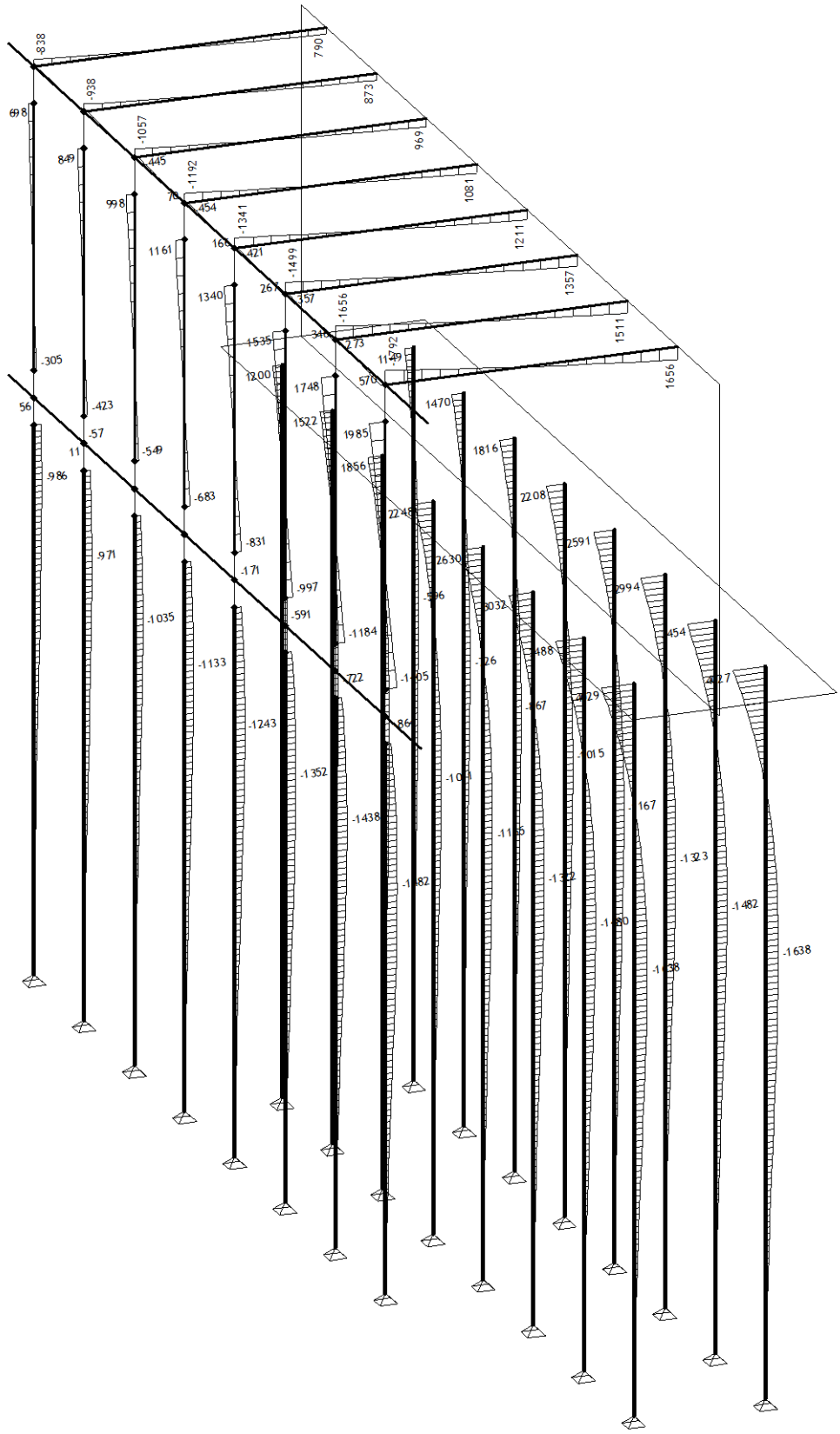
Load 7: Sz



Isometric
Beam Results: max N1= 225 / min N1= -225 kN

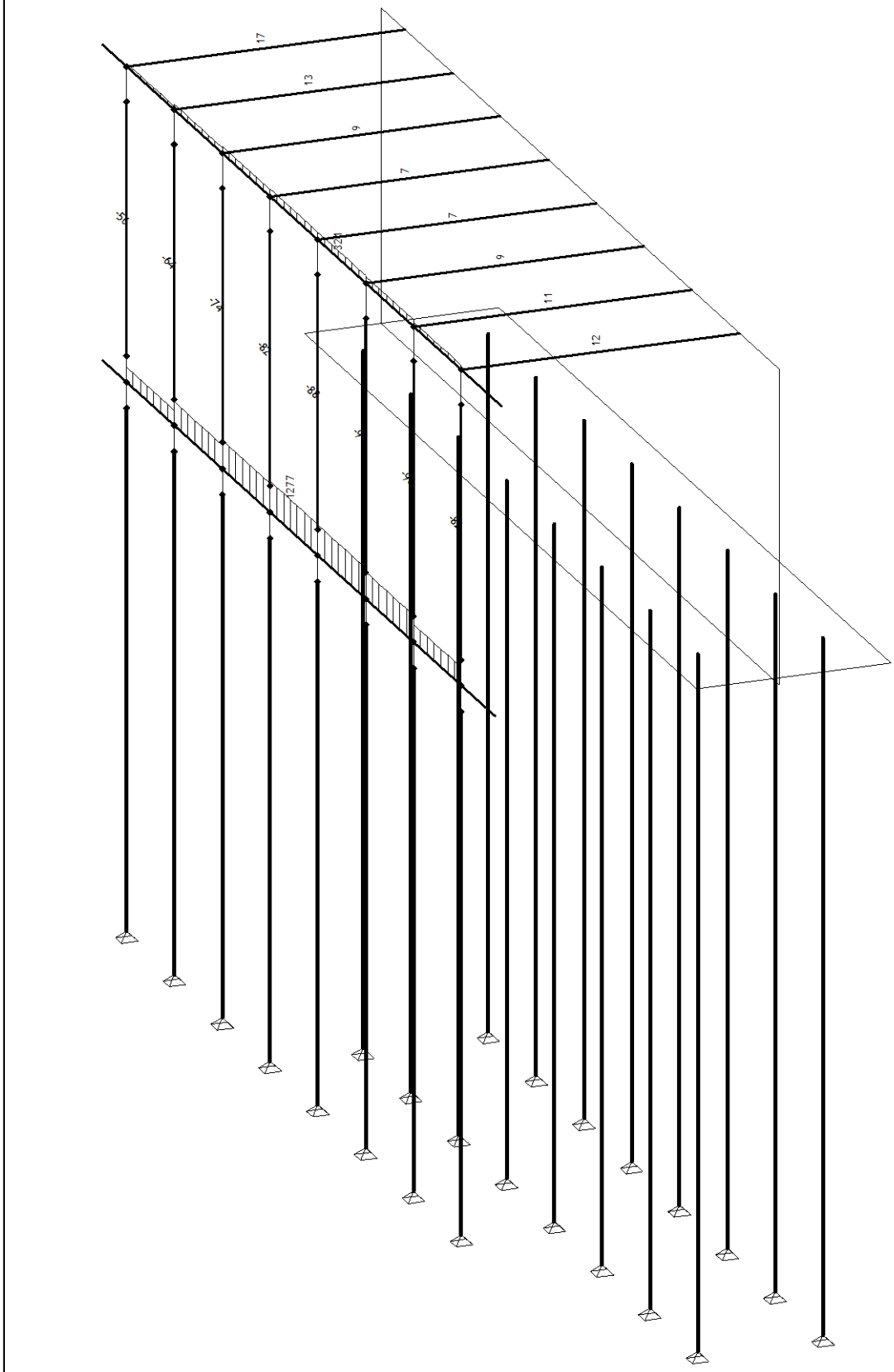

Comb1
Load 13: [Anv] 8,9
Isometric
Beam Results: max M3= 526 / min M3= -672 kNm

Comb1
Load 13: [Anv] 8,9



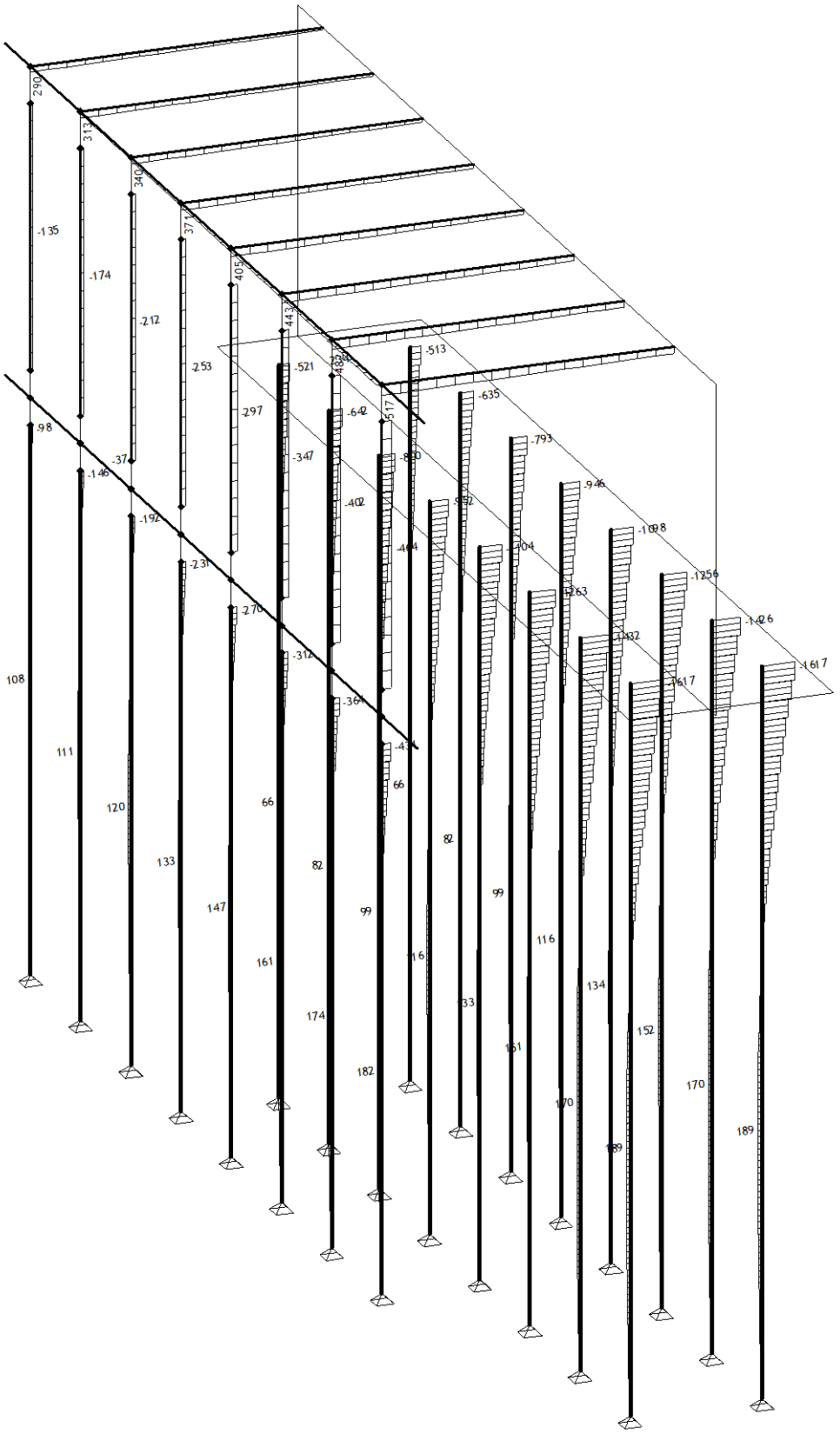
Isometric
Beam Results: max M2= 4029 / min M2= -1792 kNm

Comb1
Load 13: [Anv] 8,9



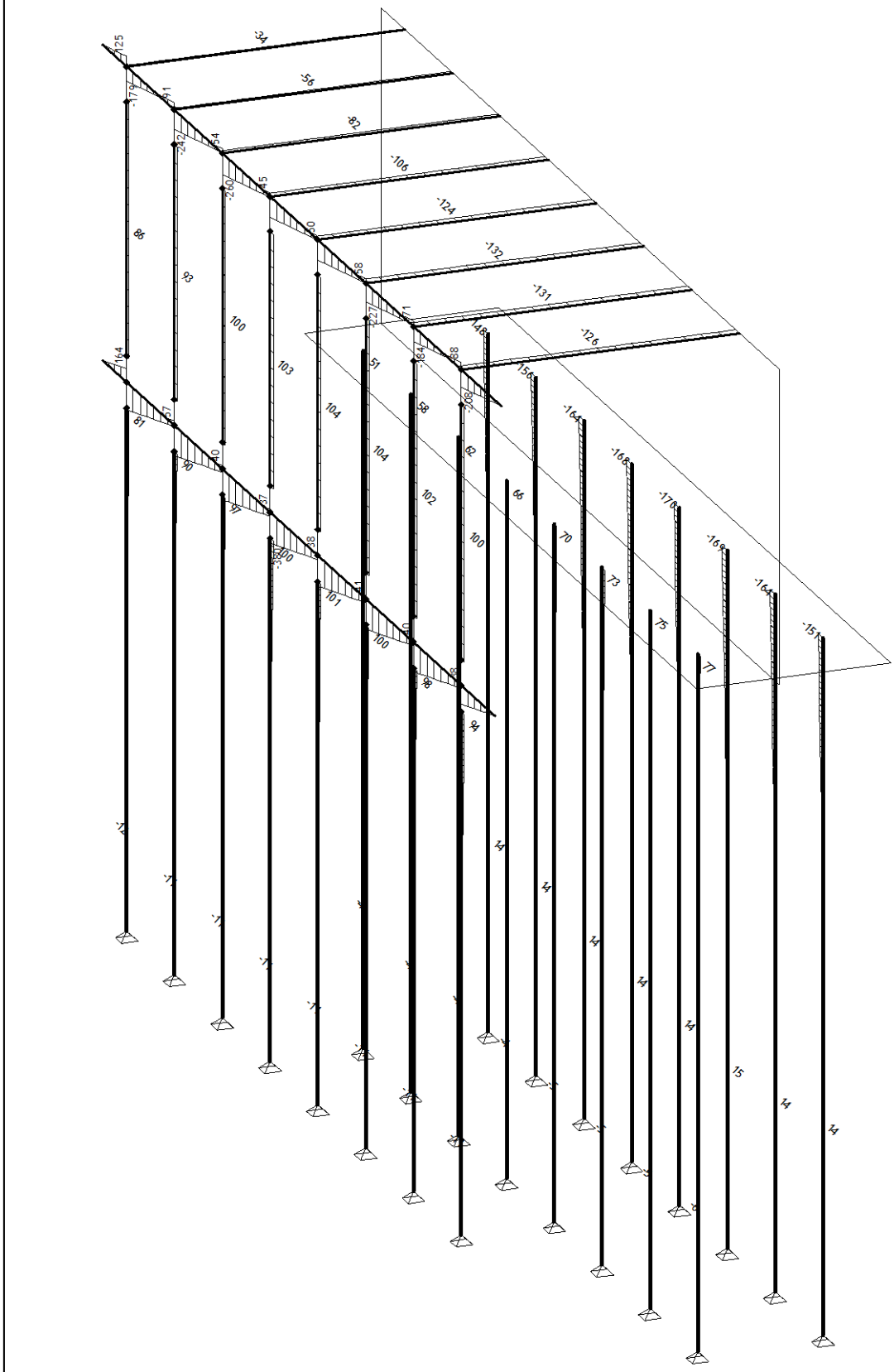
Isometric
Beam Results: max M1= 1277 / min M1= -91 kNm

Comb1
Load 13: [Anv] 8,9

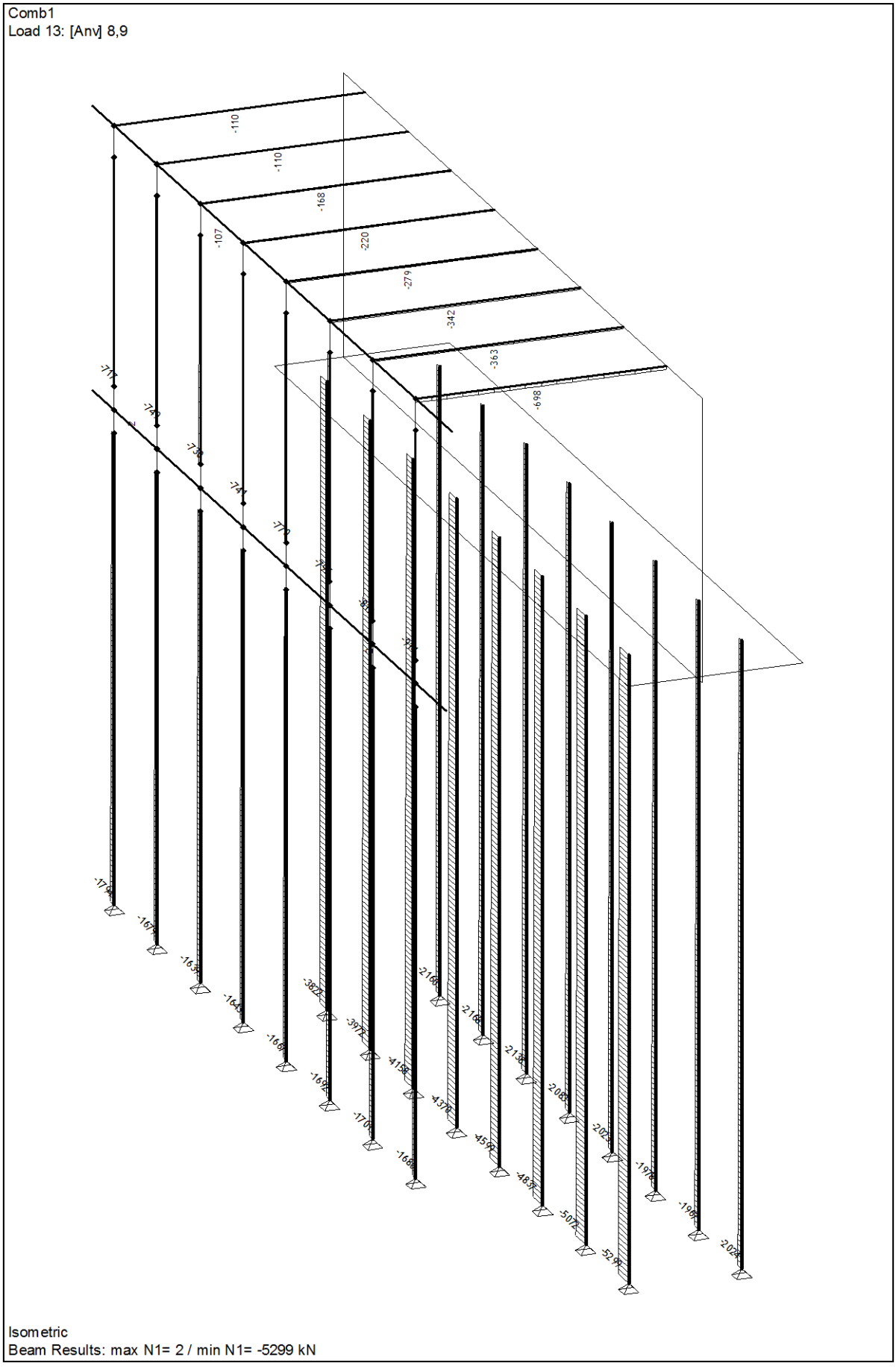


Isometric
Beam Results: max V3= 517 / min V3= -1617 kN

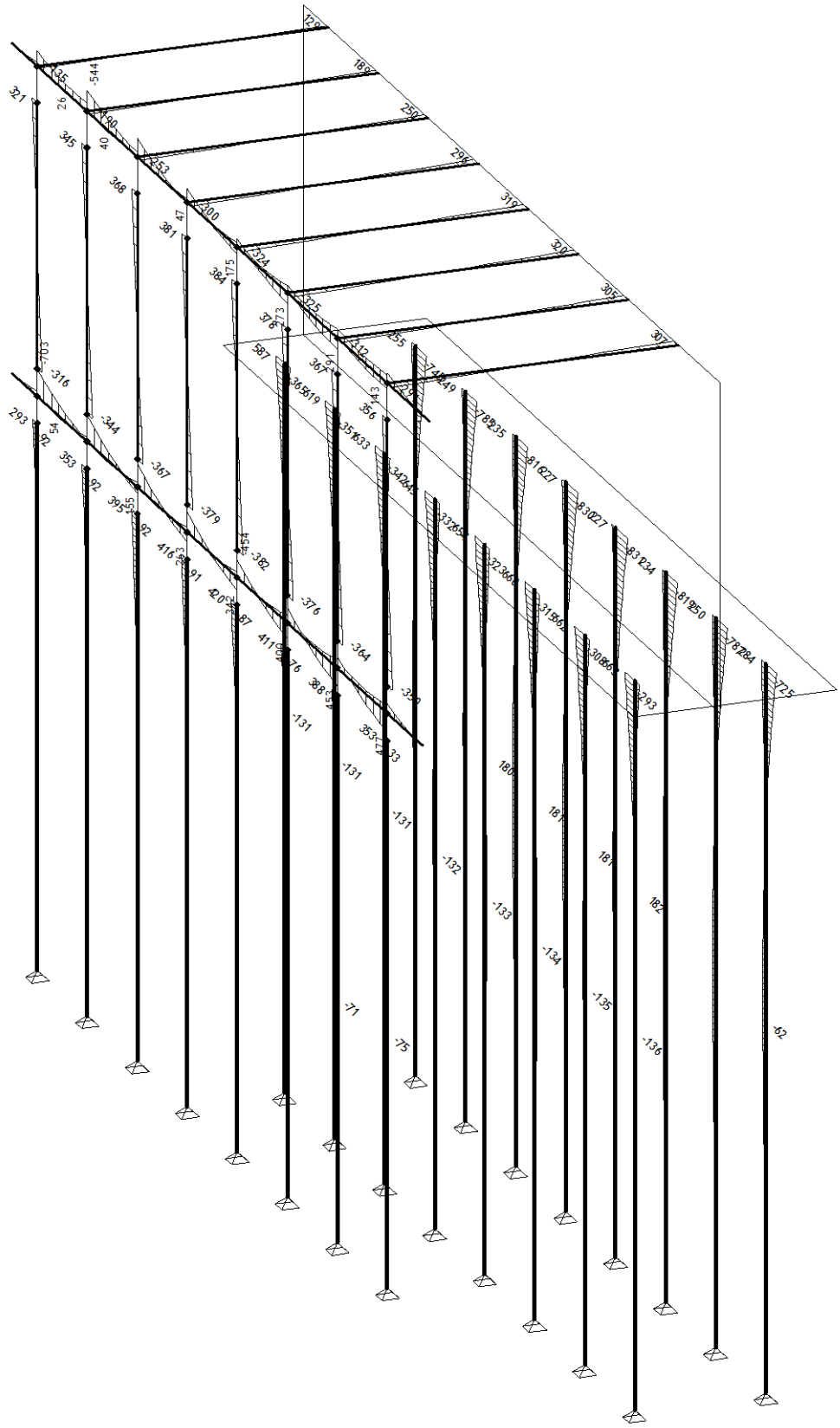
Comb1
Load 13: [Anv] 8,9



Isometric
Beam Results: max V2= 164 / min V2= -380 kN

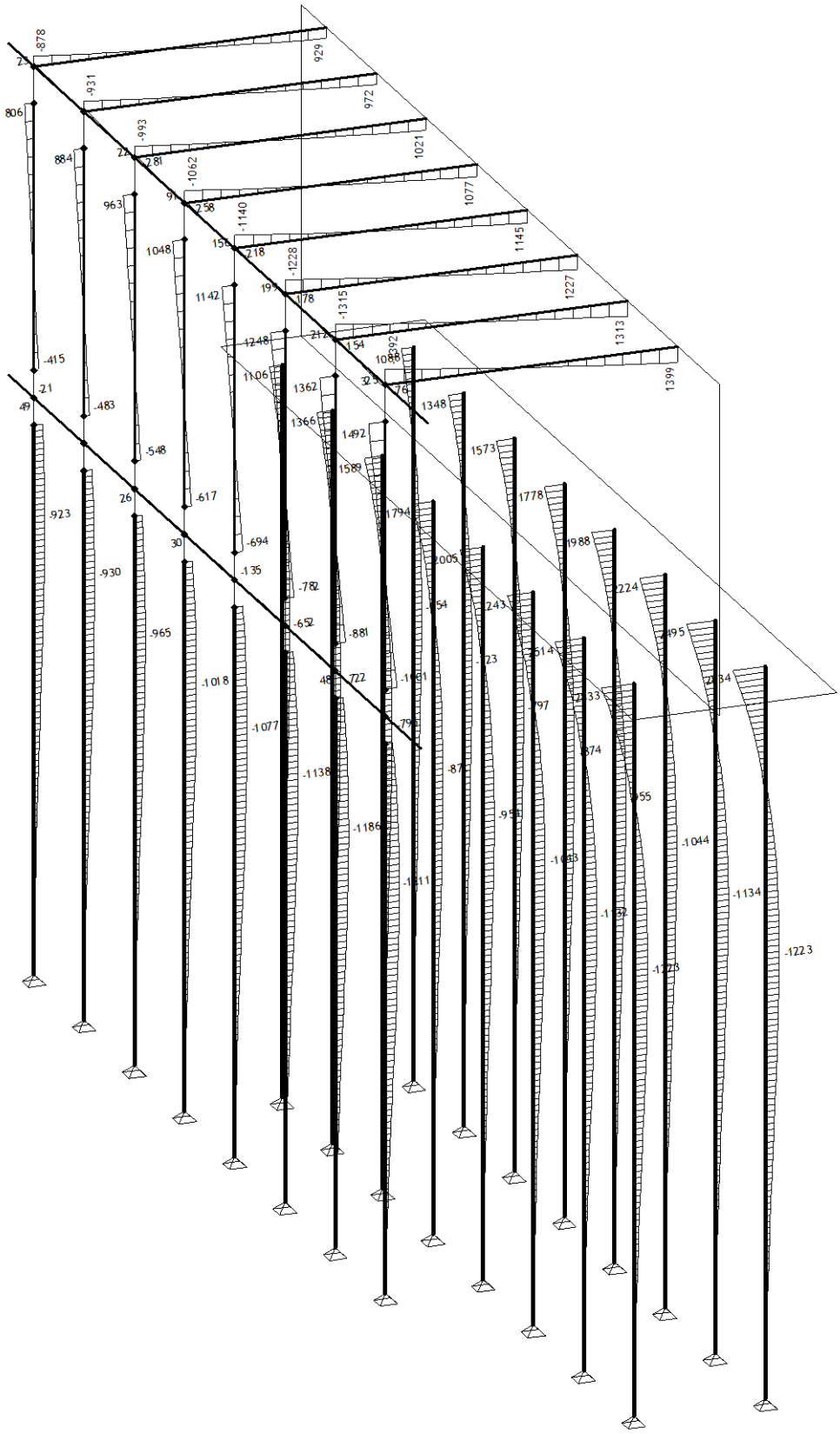

Comb1
Load 13: [Anv] 8,9
-110
-110
-168
-107
-220
-279
-342
-363
-698
Isometric
Beam Results: max N1= 2 / min N1= -5299 kN

Comb2
Load 13: [Anv] 10-12



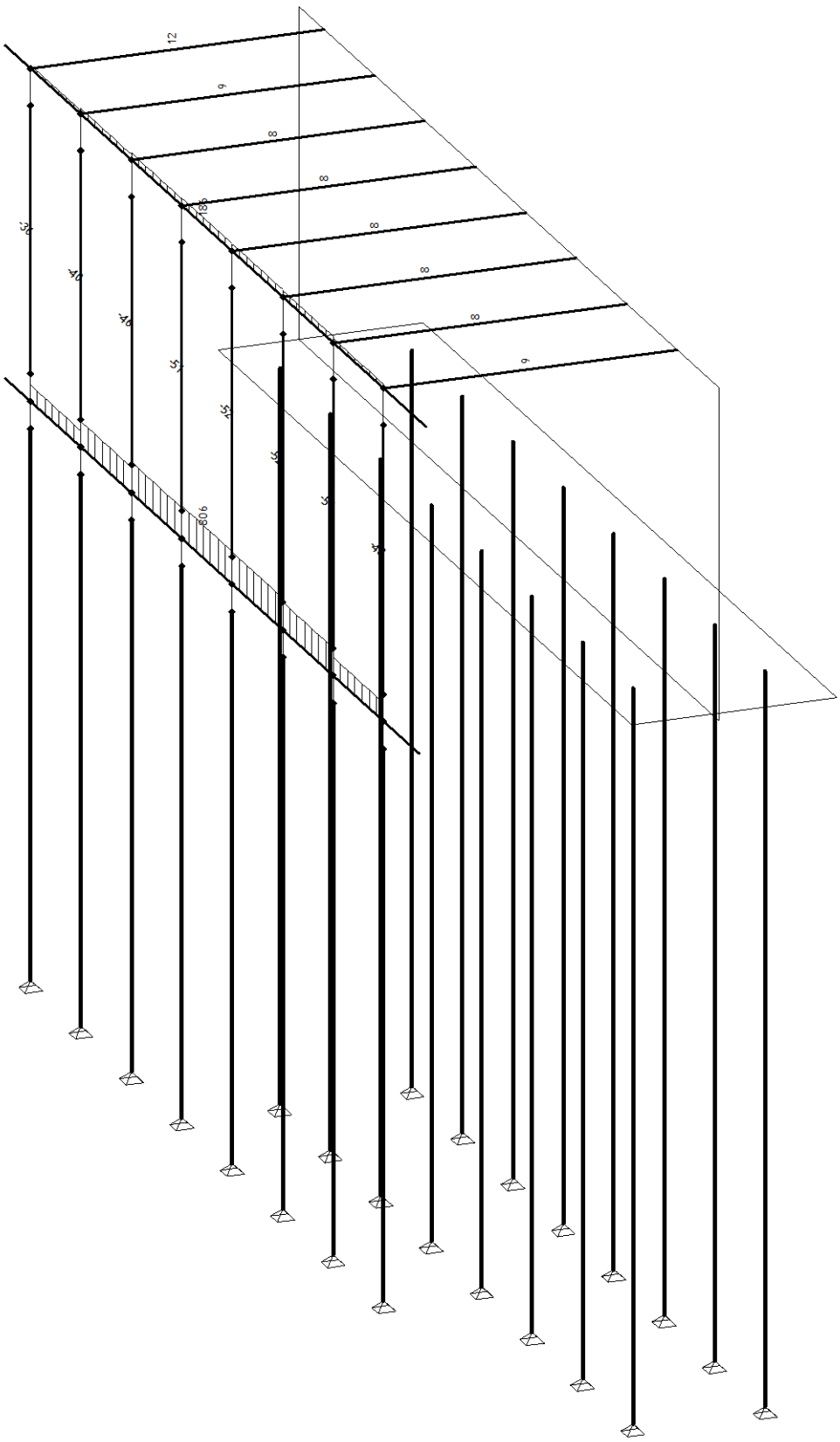
Isometric
Beam Results: max M3= 663 / min M3= -831 kNm

Comb2
Load 13: [Anv] 10-12



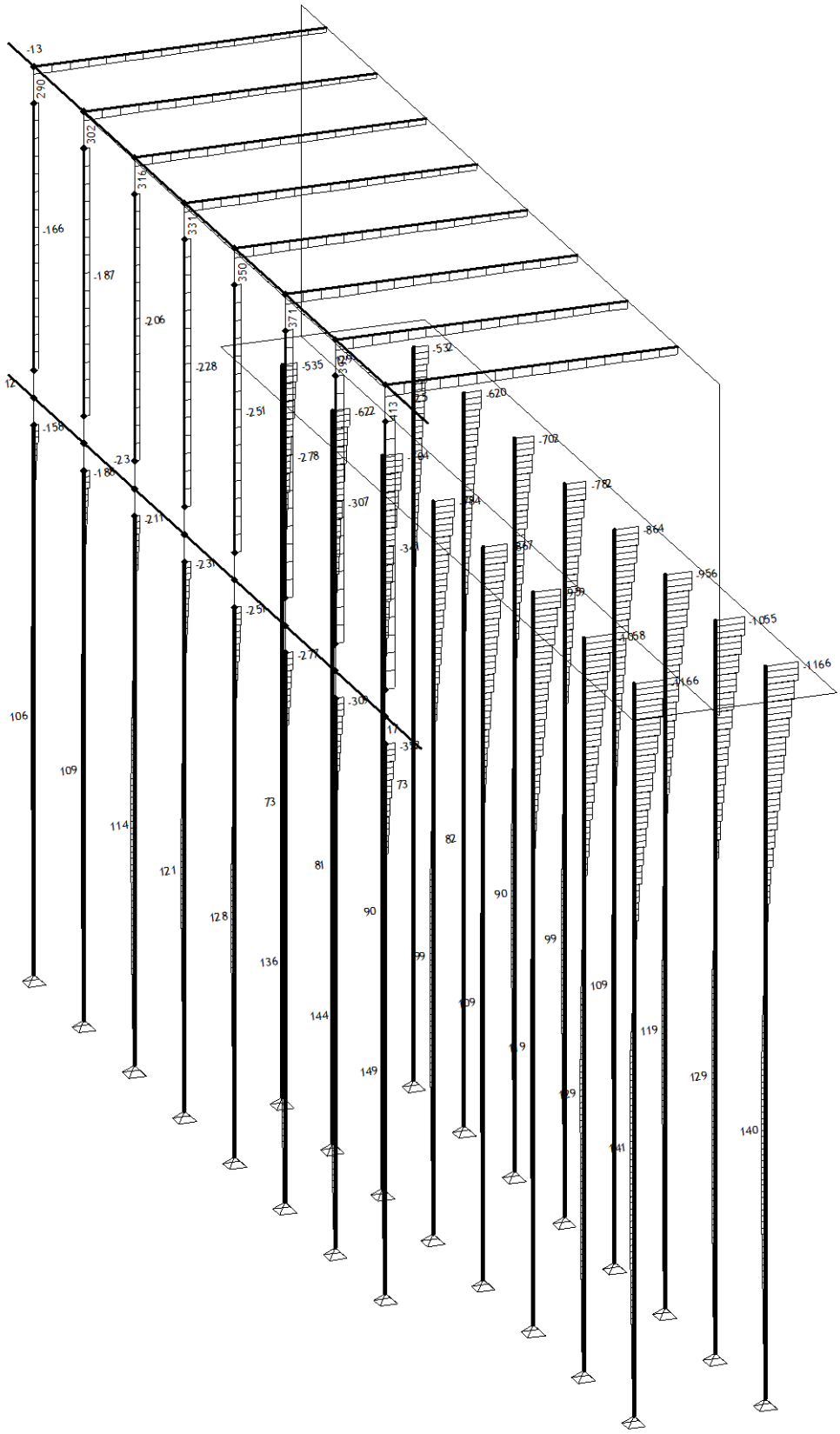
Isometric
Beam Results: max M2= 2834 / min M2= -1392 kNm

Comb2
Load 13: [Anv] 10-12



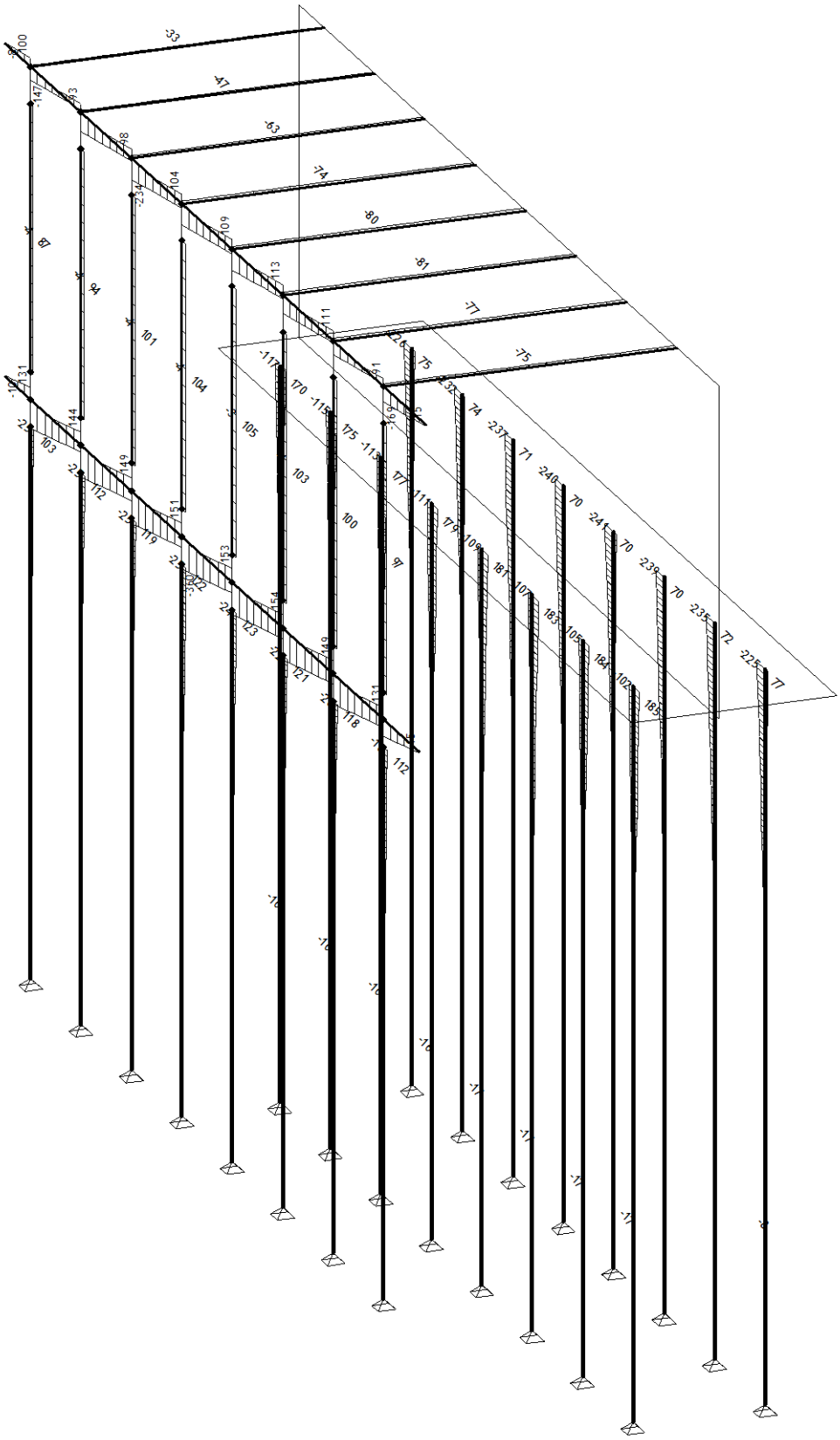
Isometric
Beam Results: max M1= 806 / min M1= -52 kNm

Comb2
Load 13: [Anv] 10-12



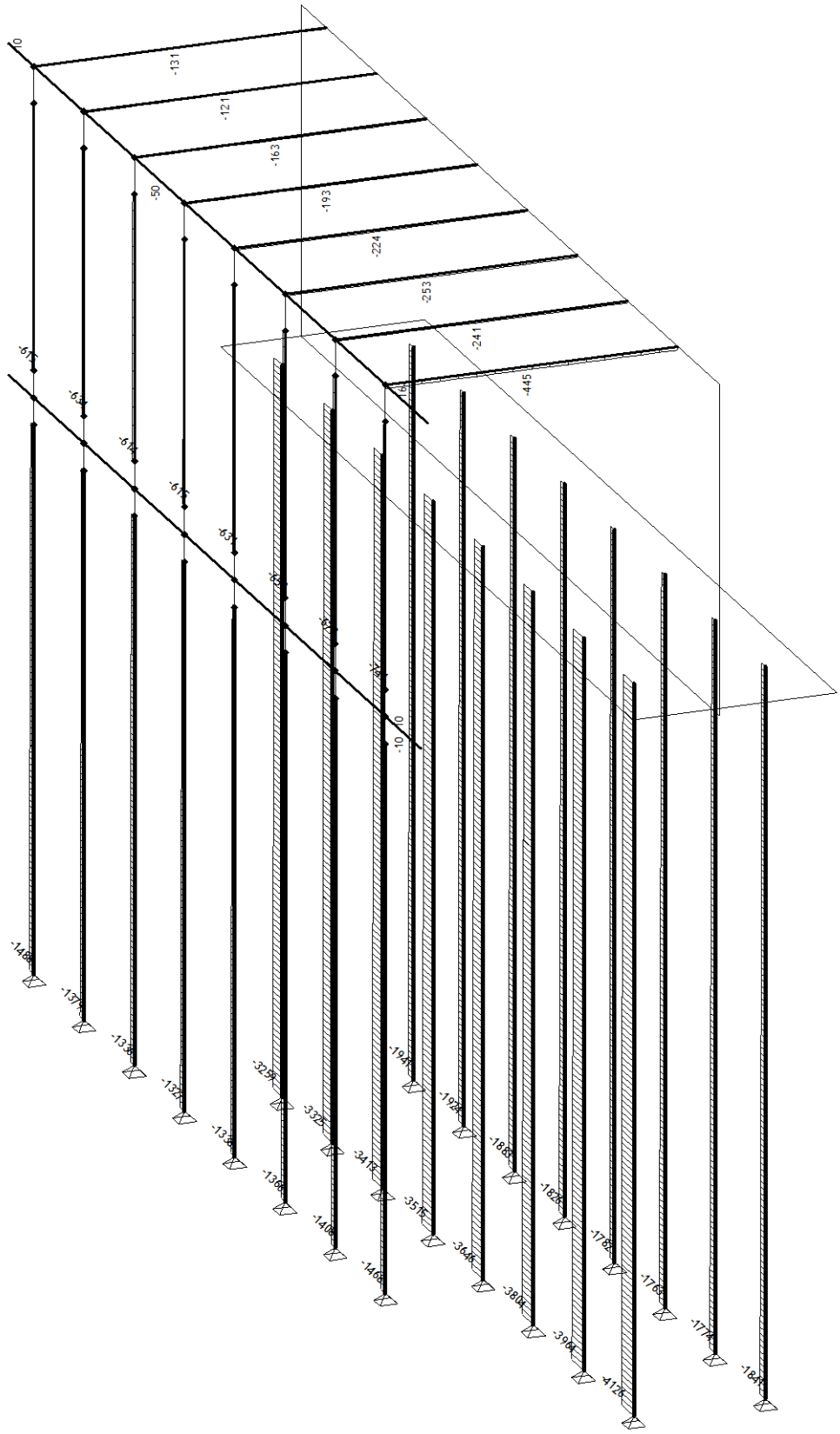
Isometric
Beam Results: max V3= 413 / min V3= -1166 kN

Comb2
Load 13: [Anv] 10-12



Isometric
Beam Results: max V2= 185 / min V2= -360 kN

Comb2
Load 13: [Anv] 10-12



Isometric
Beam Results: max N1= 16 / min N1= -4126 kN

7. **Контрола граничног стања носивости /** Analysis at the ultimate limit state (ULS)

Димензионисање / Reinforcement design

Comb 1

Сопствена тежина / Self weight

Притисак тла / Earth pressure

Воз на објекту / Train load on the structure

Comb 2

Сопствена тежина / Self weight

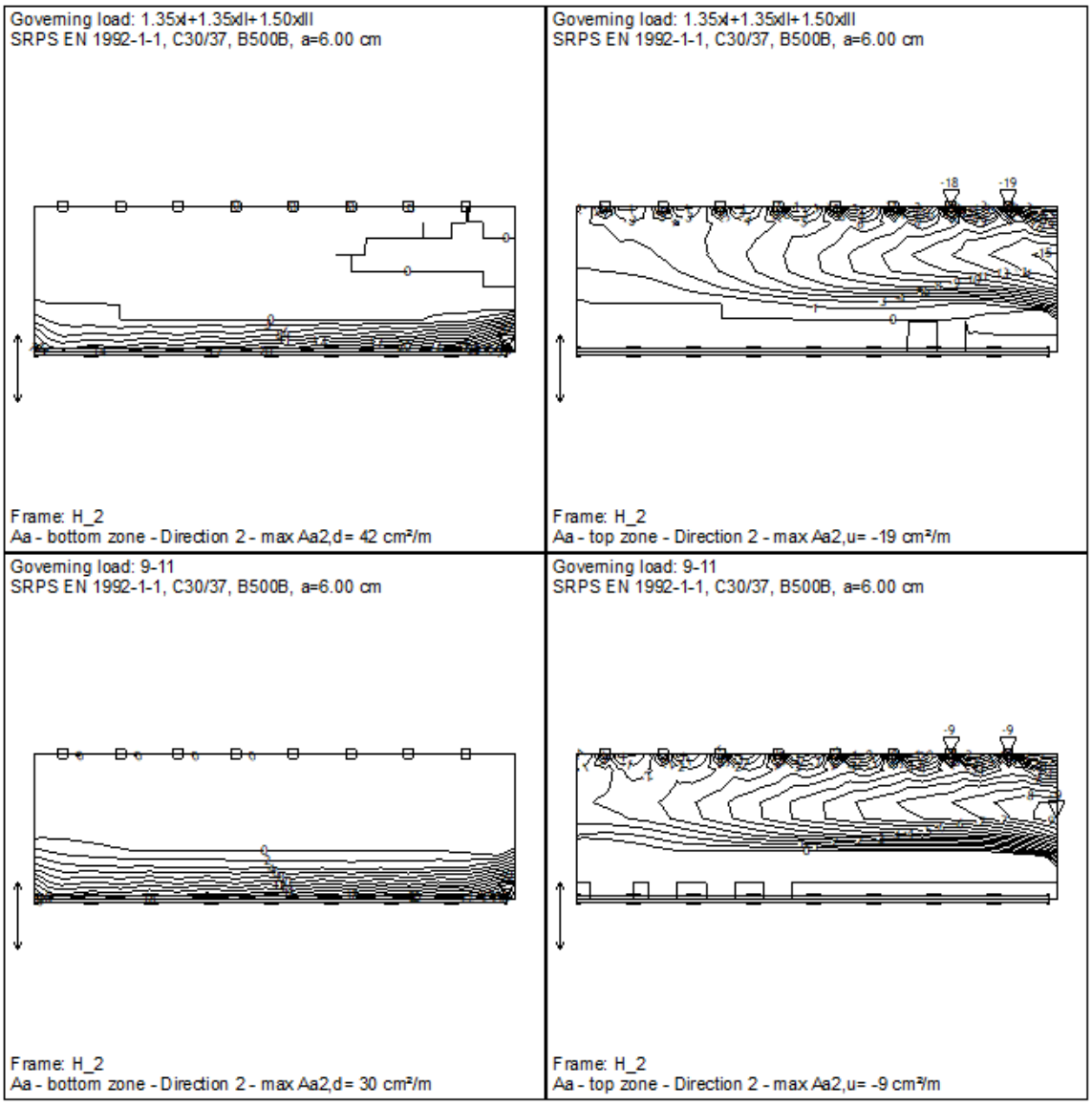
Притисак тла / Earth pressure

Сеизмичко дејство / Seizmic load

7.1. Улаз / Entrance

7.1.1. Зид / Wall

Comb 1



Усвојена арматура / Provided reinforcement

Direction 1: (α=0°)

±Φ16/15 (Aa = ÷13.40 cm2/m)

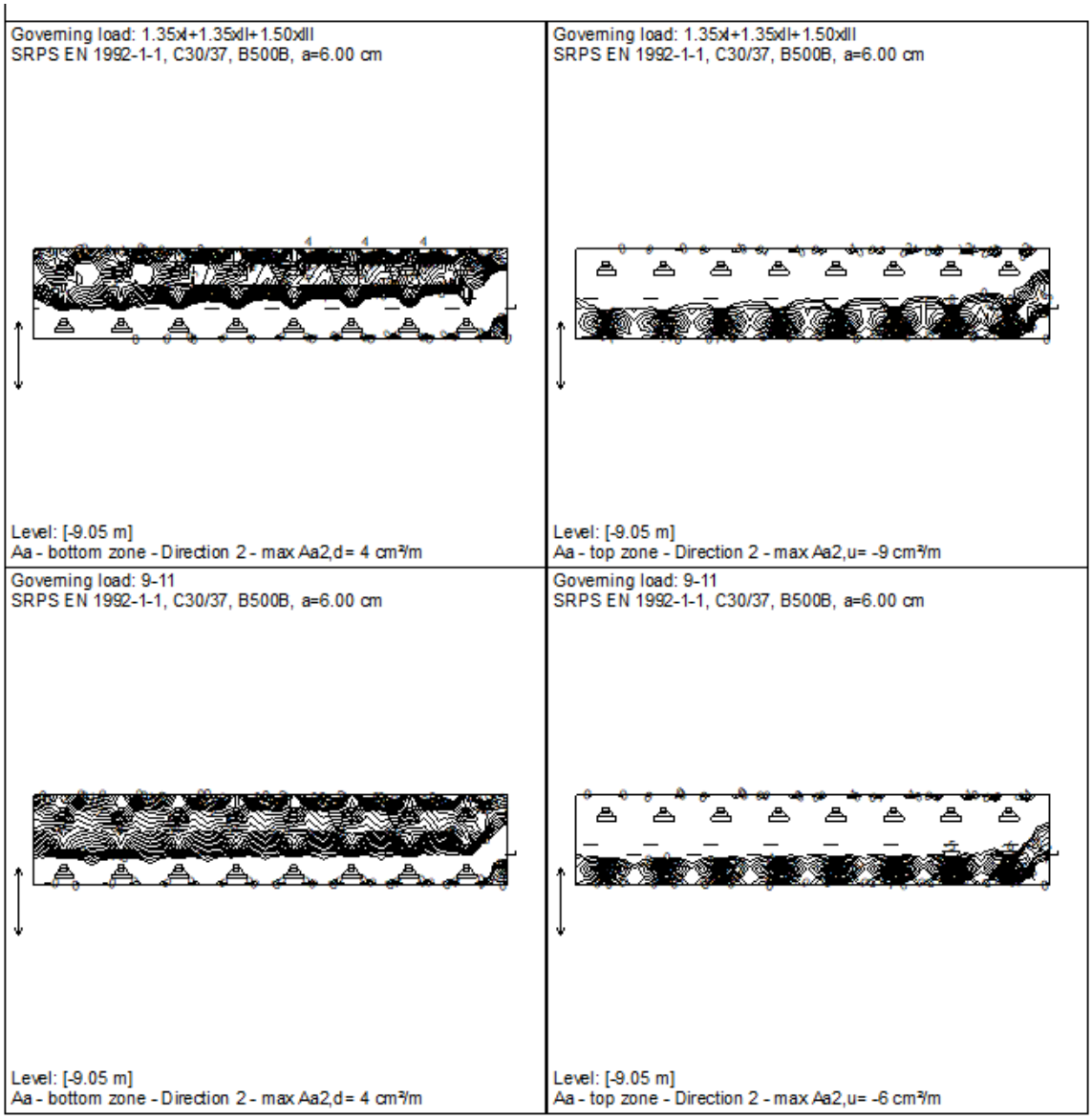
Direction 2: (α=90°) -

Φ25/15 (Aa = 32.71 cm2/m) → **спољна страна /** outer side

Φ20/15 (Aa = 20.93 cm2/m) → **унутрашња страна** / inner side

7.1.2. **Темељ /** Foundation

Comb 1



Усвојена арматура / Provided reinforcement

Direction 1: (α=0°)

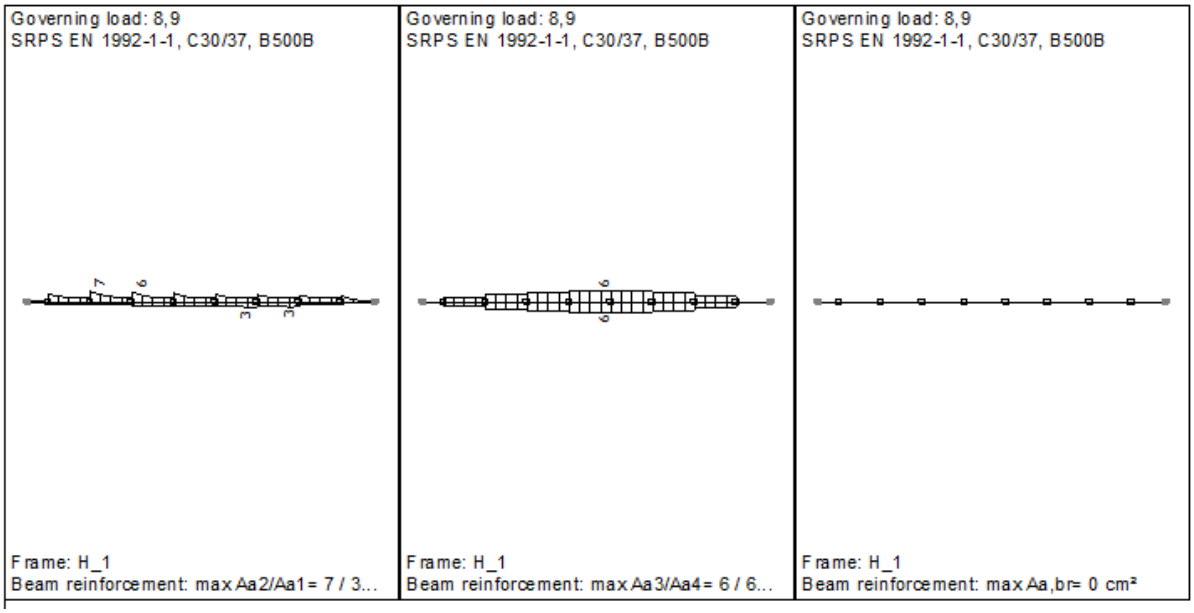
±Φ20/15 (Aa = ±20.93 cm2/m)

Direction 2: (α=90°) -

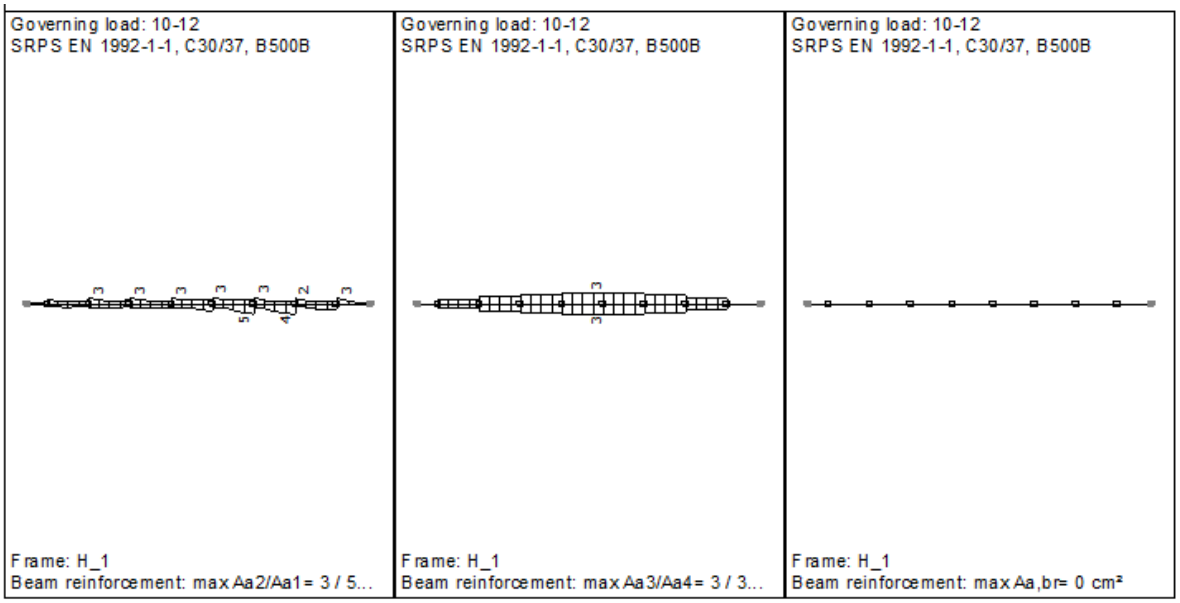
±Φ20/15 (Aa = ±20.93 cm2/m)

7.1.3. **Лежишна греда /** Bearing beam

Comb 1



Comb 2



Усвојена арматура / Provided reinforcement

Подужна арматура / Longitudinal reinforcement

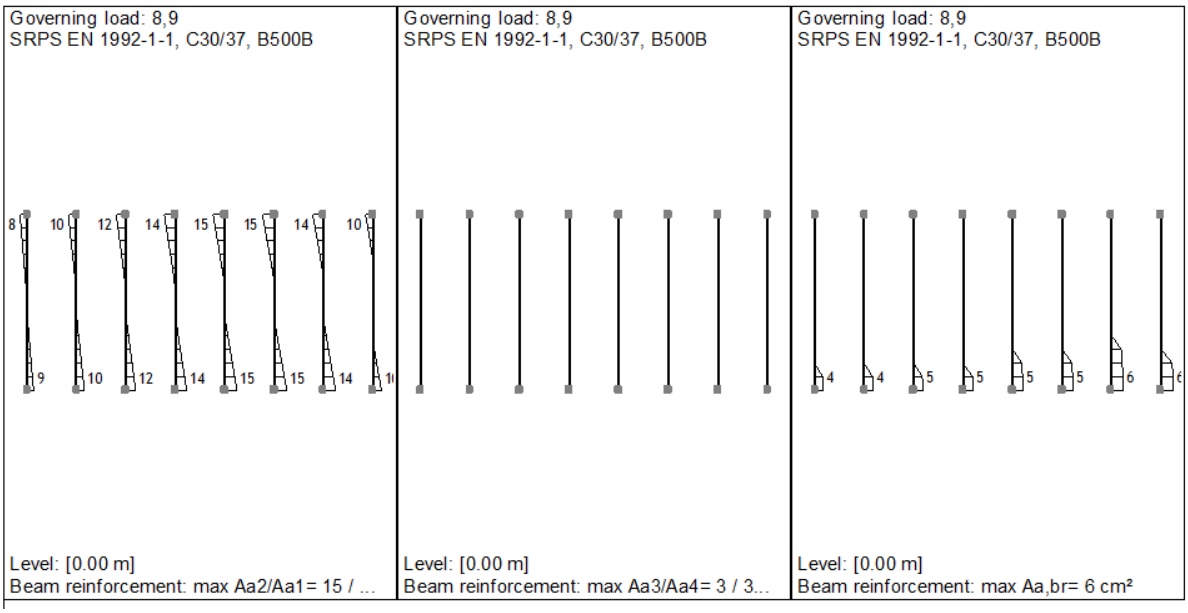
±7Φ20/15 (Aa = ±21.98 cm2)

узенгије / stirrups

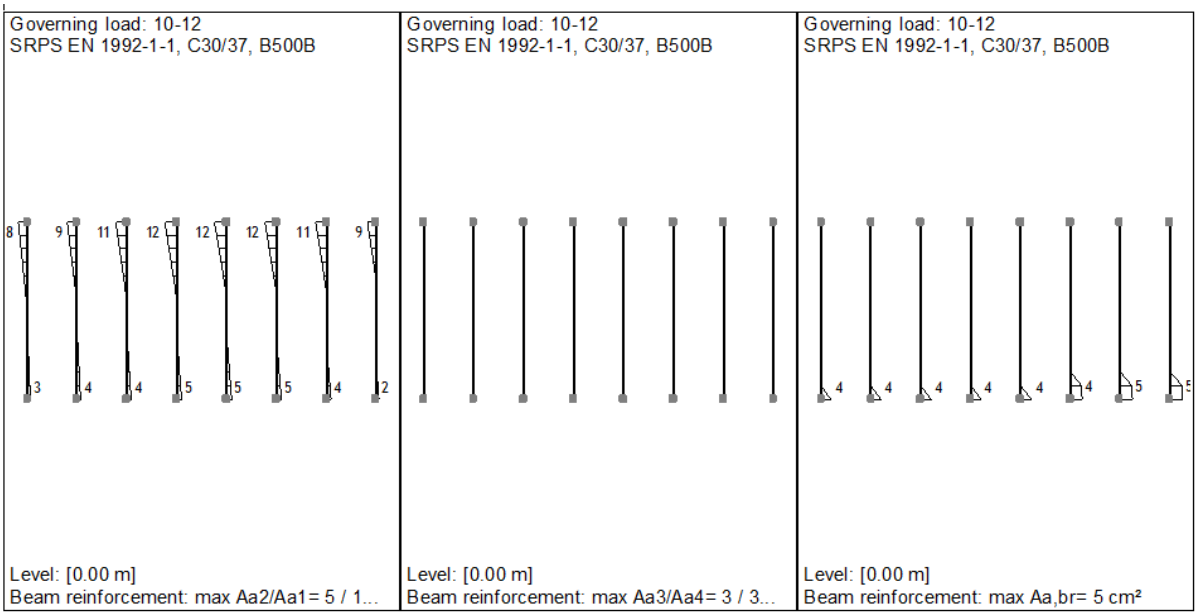
Φ16/15 (Aa = 13.40 cm2/m)

7.1.4. **Попречна греда /** Cross beam

Comb 1



Comb 2



Усвојена арматура / Provided reinforcement

Подужна арматура / Longitudinal reinforcement

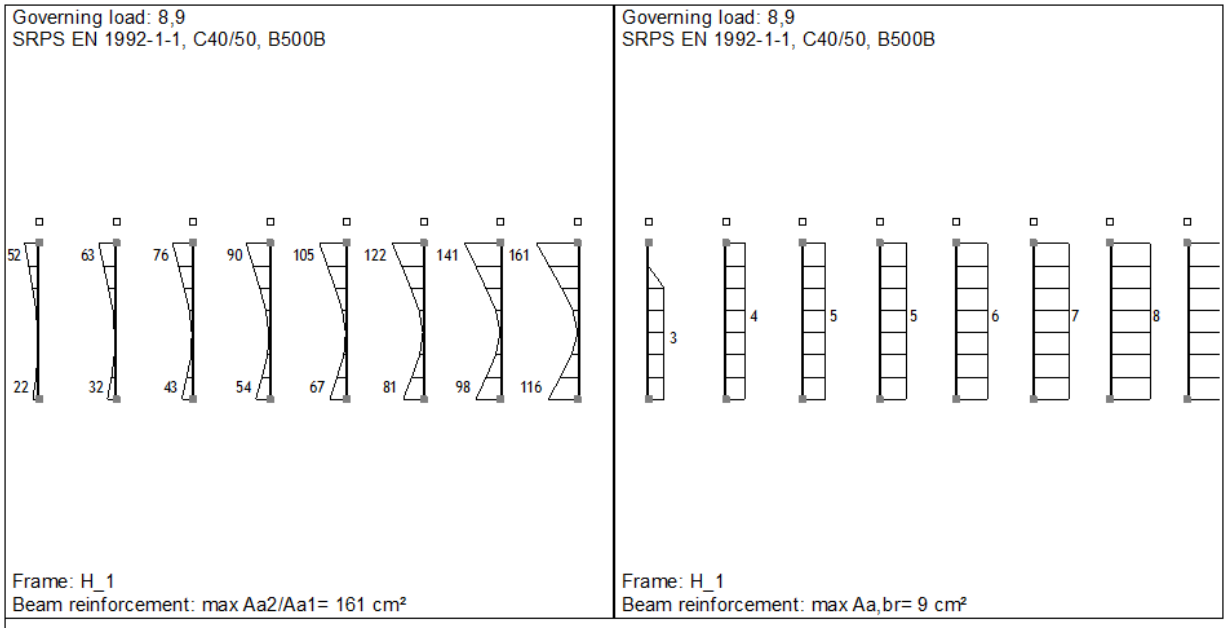
±5Φ20/15 (Aa = ±15.70 cm2)

узенгије / stirrups

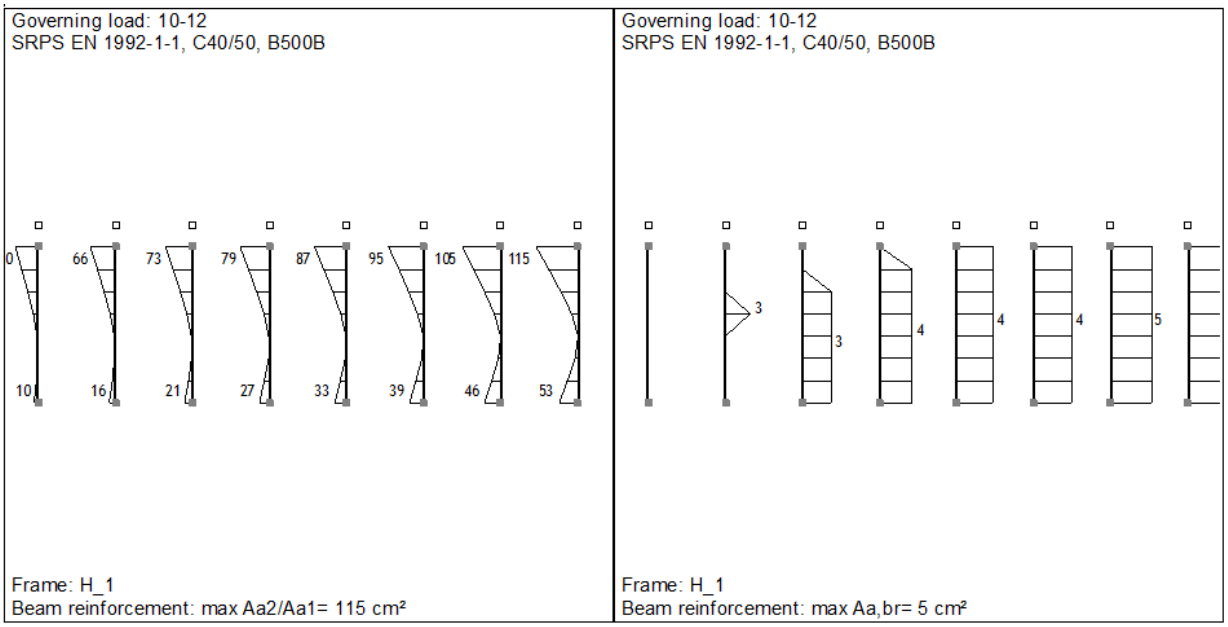
Φ14/15 (Aa = 10.26 cm2/m)

7.1.5. **Стубови /** Piers

Comb 1



Comb 2



Усвојена арматура / Provided reinforcement

Вертикална арматура / Vertical reinforcement

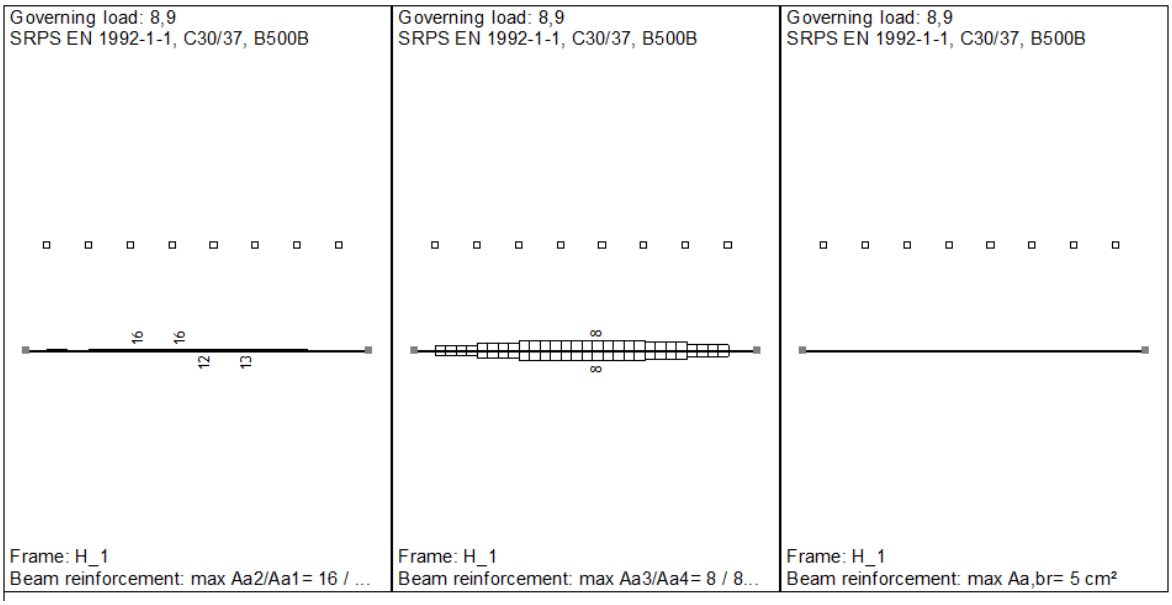
27Φ28/7.5 (Aa = 166.05 cm2)

узенгије / stirrups

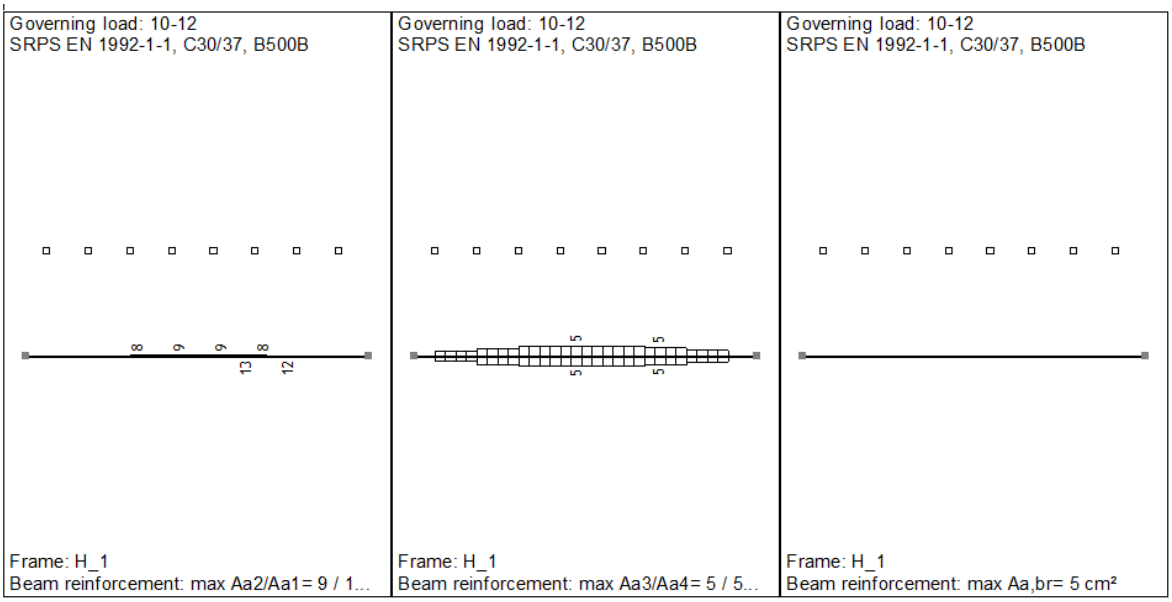
Φ14/15 (Aa = 10.26 cm2/m)

7.1.6. **Темељна греда /** Foundation beam

Comb 1



Comb 2



Усвојена арматура / Provided reinforcement

Подужна арматура / Longitudinal reinforcement

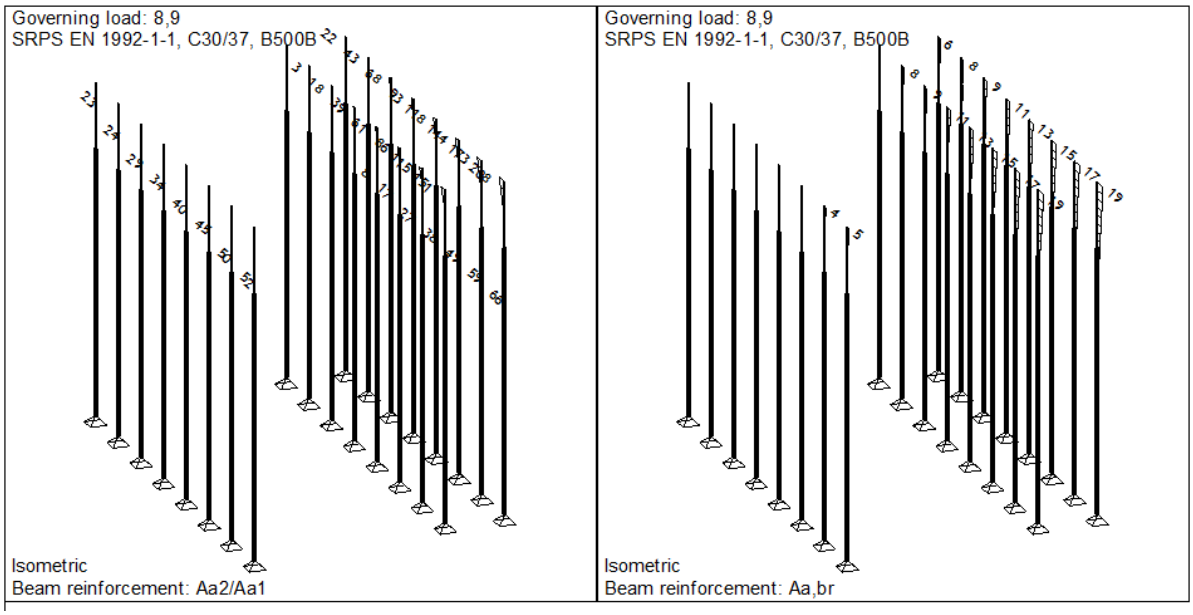
±12Φ20/15 (Aa = ±37.68 cm2)

узенгије / stirrups

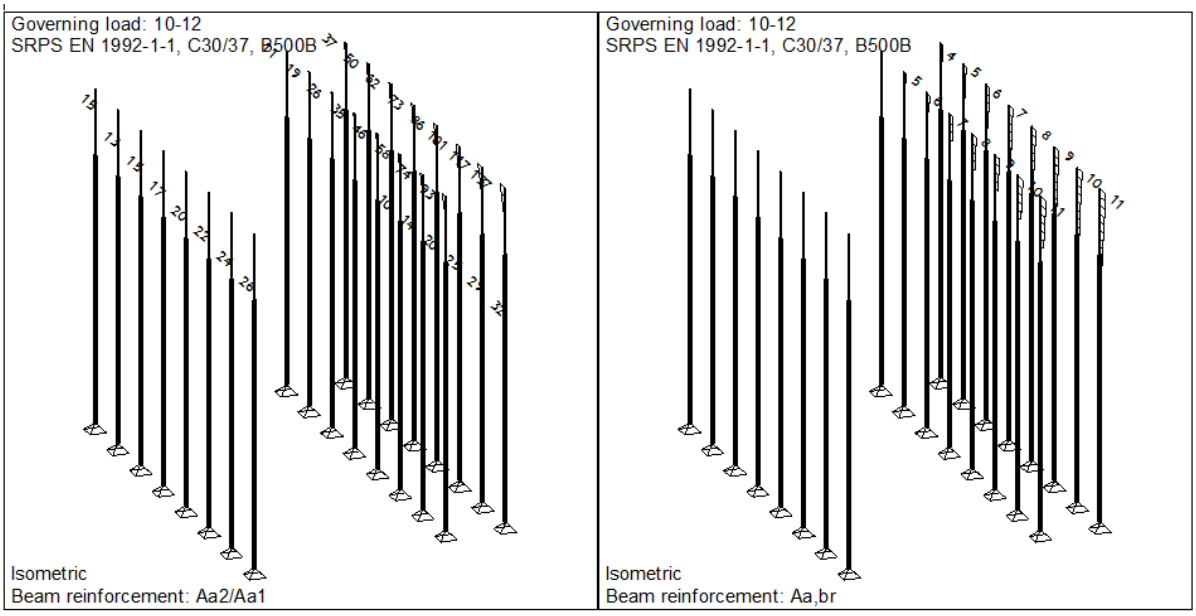
Φ16/15 (Aa = 13.40 cm2/m)

7.1.7. **Шипови /** Piles

Comb 1



Comb 2



Усвојена арматура / Provided reinforcement

Шипови испод темељне плоче / Piles under foundation slab

33Φ28/10 (Aa = 202.95 cm2) **Вертикална арматура** / Vertical reinforcement

Φ14/15 (Aa = 10.26 cm2/m) → **узенгије** / stirrups

Φ14/7.5 (Aa = 20.53 cm2/m) → **узенгије** / stirrups → **Горња зона** / Top zone 1.00 m

Шипови испод темељне греде / Piles unde foundation beam

20Φ20/15 (Aa = 62.80 cm2) **Вертикална арматура** / Vertical reinforcement

Φ12/15 (Aa = 7.54 cm2/m) → **узенгије** / stirrups

Φ12/10 (Aa = 11.30 cm2/m) → **узенгије** / stirrups → **Горња зона** / Top zone 1.00 m

Максимална сила у шипу / Maximal axial force

Шипови испод темељне плоче / Piles under foundation slab

Nmax = 4762 kN ULS → L = 20.0 m

Nmax = 3484 kN SLS

Шипови испод темељне греде / Piles unde foundation beam

Nmax = 1120 kN ULS → L = 15.0 m

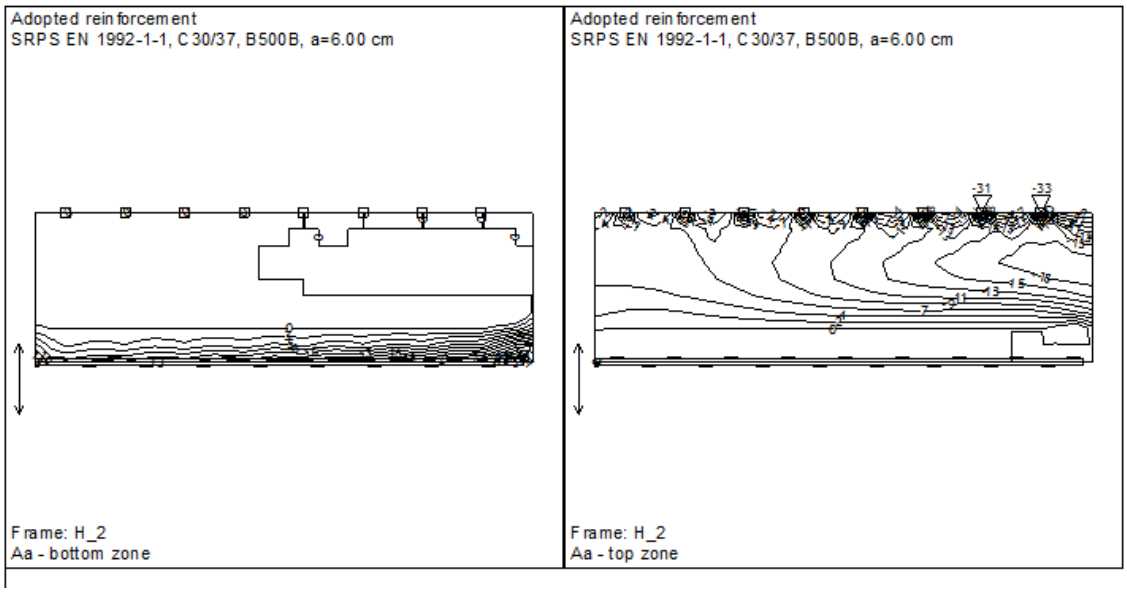
Nmax = 823 kN SLS

Frame	Length of pile	Diameter of pile	Analysis results, SRPS EN 1997-1, DA-2			Settlement of pile group
	L_s (m)	d (m)	R_s (kN)	R_b (kN)	R_c (kN)	s (mm)
2.2	15.0	1.2	4254.20	2513.85	6023.56	-
	16.0	1.2	4706.86	2617.69	6518.85	-
	16.95	1.2	5153.86	2716.34	7004.48	-
	18.0	1.2	5667.15	7063.44	11330.23	-
	19.0	1.2	6174.78	2929.22	8102.56	-
	20.0	1.2	6700.72	3033.06	8663.06	-
	21.0	1.2	7244.99	3136.91	9239.89	-
	22.0	1.2	7807.58	3240.75	9833.01	-
	23.0	1.2	8388.48	3344.60	10442.44	-
	24.0	1.2	8987.71	3448.44	11068.18	-
	25.0	1.2	9605.26	3552.28	11710.22	-
	26.0	1.2	10235.27	3656.13	12363.34	-
	27.0	1.2	10865.64	3759.97	13016.80	-
	28.0	1.2	11496.02	3863.82	13670.25	-
	29.0	1.2	12126.39	3967.66	14323.70	-

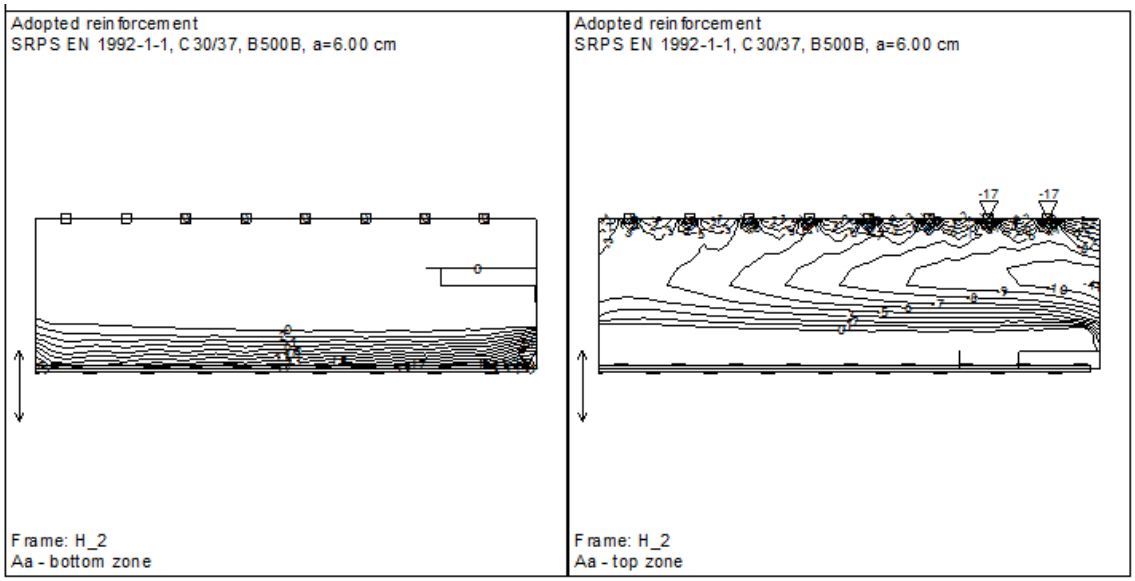
7.2. **Излаз** / Exit

7.2.1. **Зид** / Wall

Comb 1



Comb 2



Усвојена арматура / Provided reinforcement

Direction 1: (α=0°)

±Φ16/15 (Aa = ÷13.40 cm2/m)

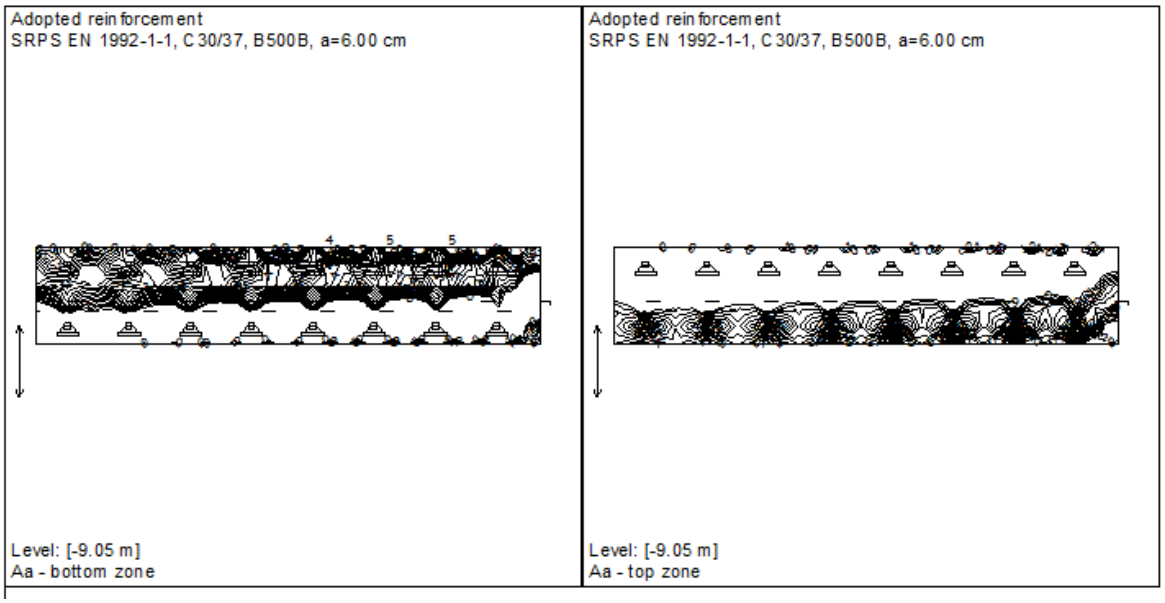
Direction 2: (α=90°) -

Φ25/15 (Aa = 32.71 cm2/m) → **спољна страна /** outer side

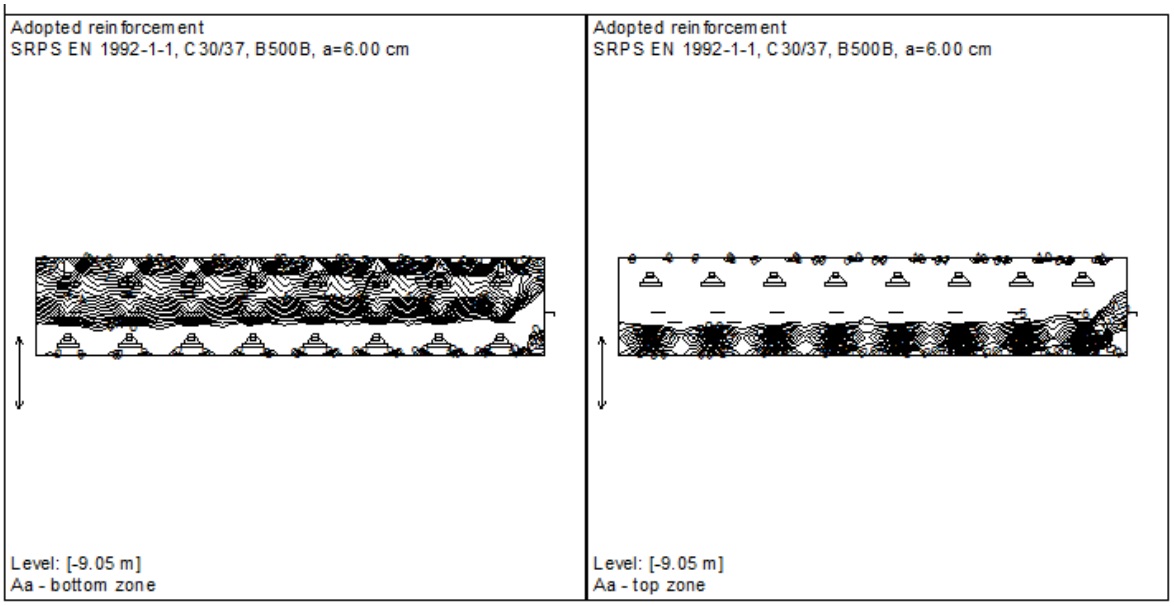
Φ25/15 (Aa = 32.71 cm2/m) → **унутрашња страна** / inner side

7.2.2. **Темељ /** Foundation

Comb 1



Comb 2



Усвојена арматура / Provided reinforcement

Direction 1: (α=0°)

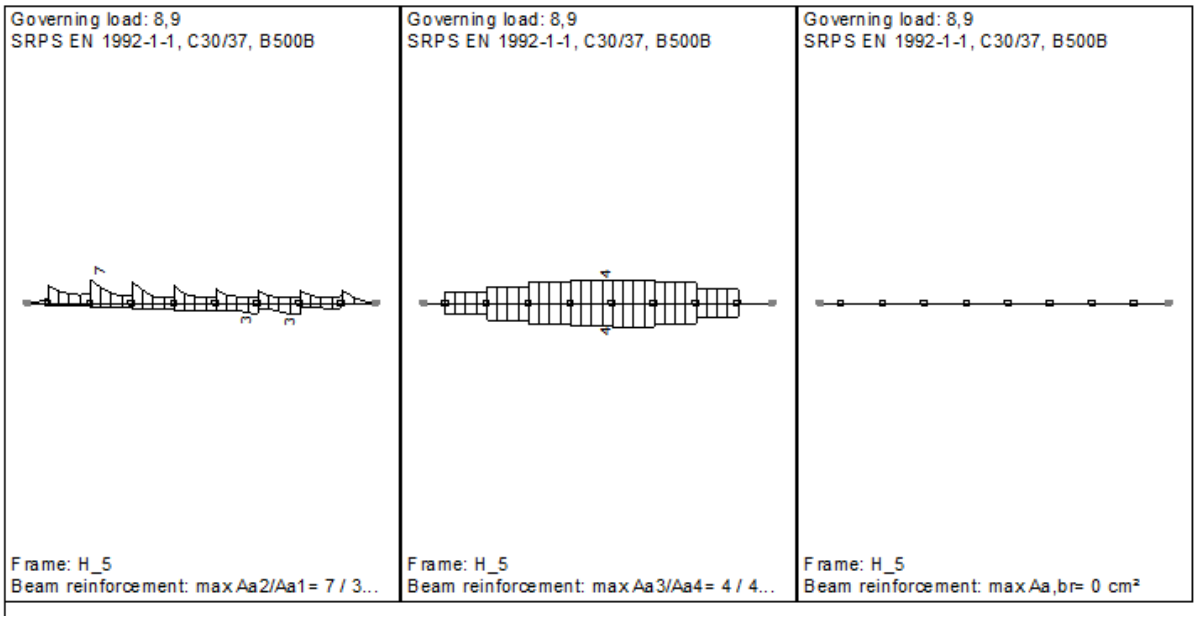
±Φ20/15 (Aa = ±20.93 cm2/m)

Direction 2: (α=90°) -

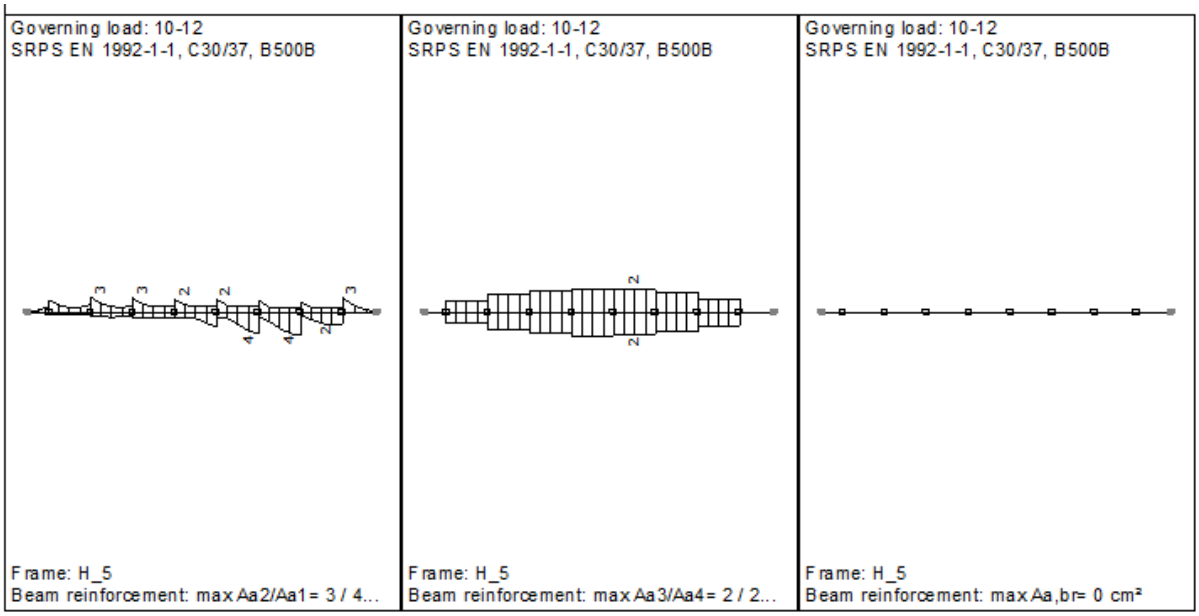
±Φ20/15 (Aa = ±20.93 cm2/m)

7.2.3. **Лежишна греда /** Bearing beam

Comb 1



Comb 2



Усвојена арматура / Provided reinforcement

Подужна арматура / Longitudinal reinforcement

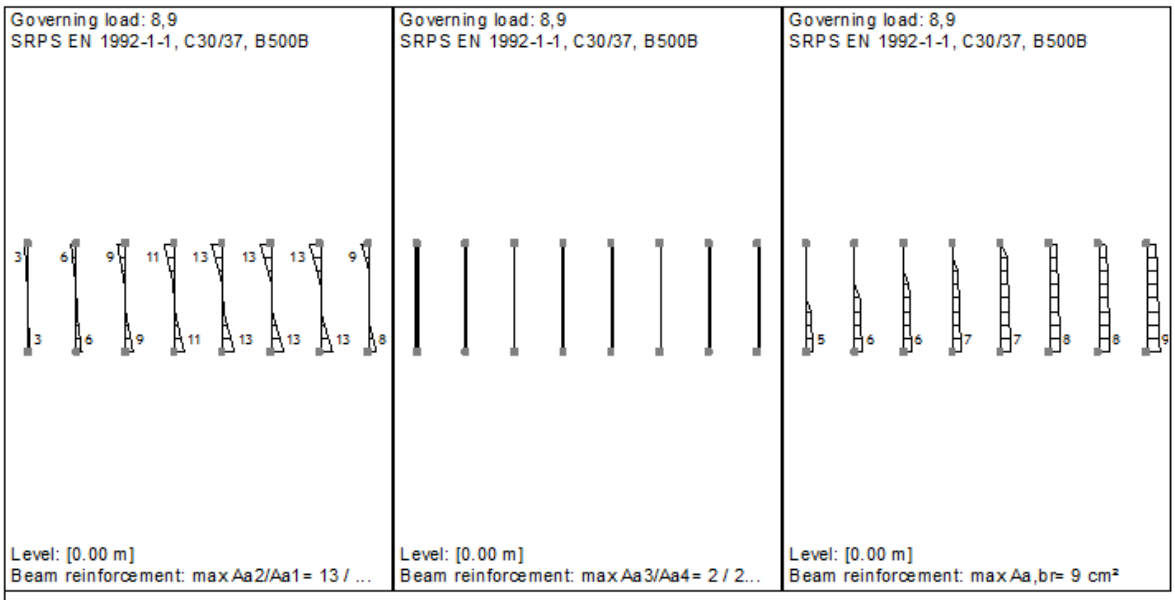
±7Φ20/15 (Aa = ±21.98 cm2)

узенгије / stirrups

Φ16/15 (Aa = 13.40 cm2/m)

7.2.4. **Попречна греда /** Cross beam

Comb 1



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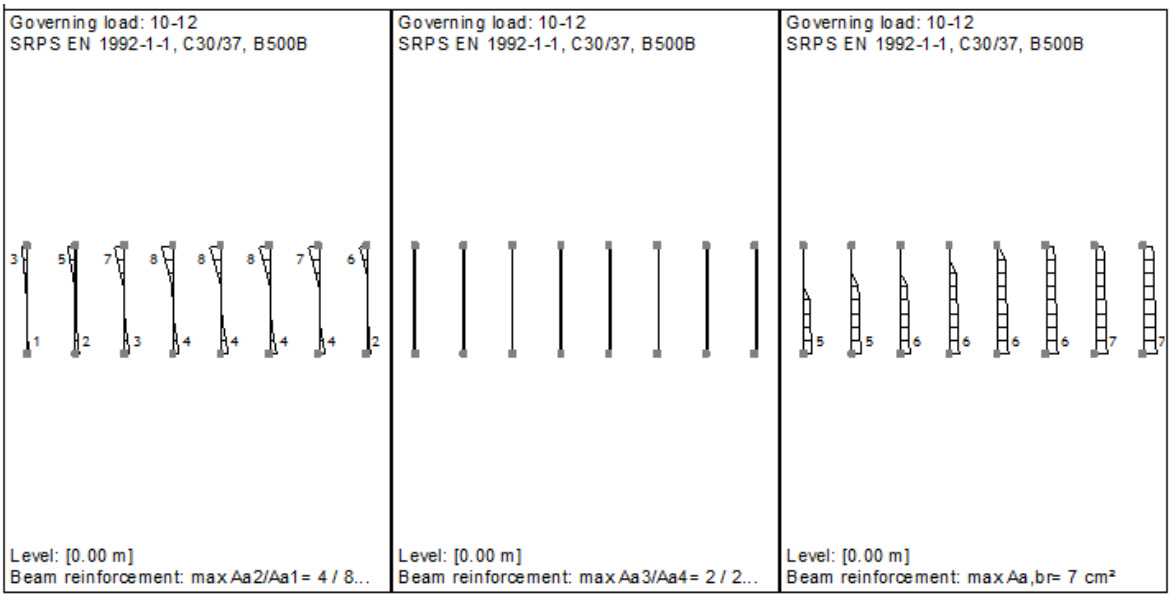


Усвојена арматура / Provided reinforcement

Подужна арматура / Longitudinal reinforcement

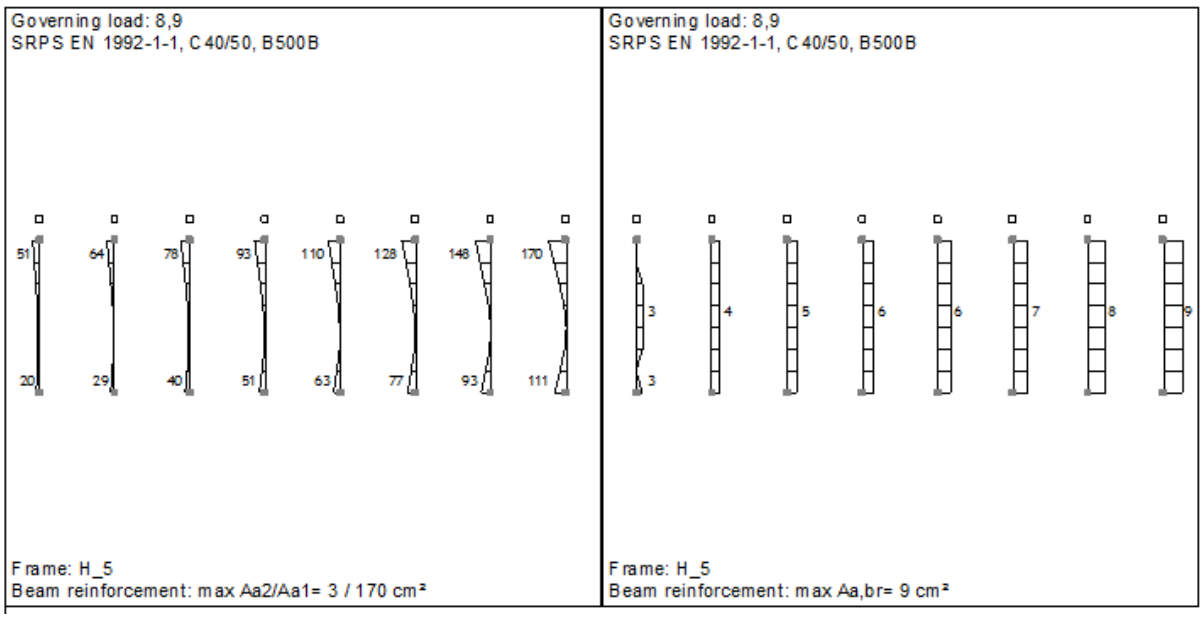
±5Φ20/15 (Aa = ±15.70 cm2)

узенгије / stirrups

Φ14/15 (Aa = 10.26 cm2/m)

7.2.5. **Стубови /** Piers

Comb 1



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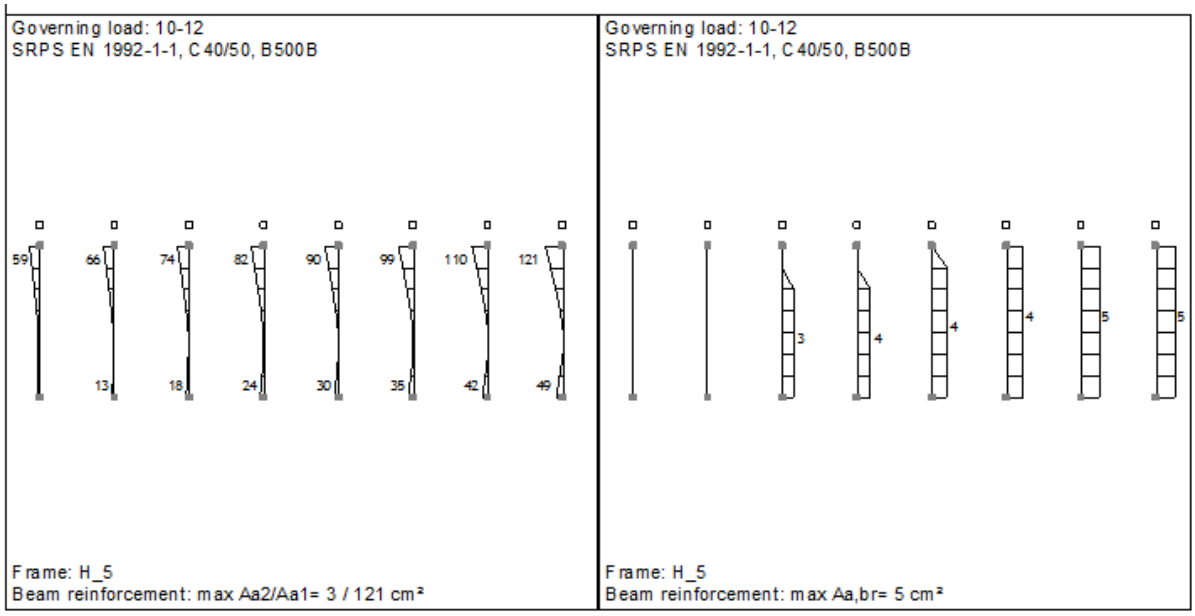


Усвојена арматура / Provided reinforcement

Вертикална арматура / Vertical reinforcement

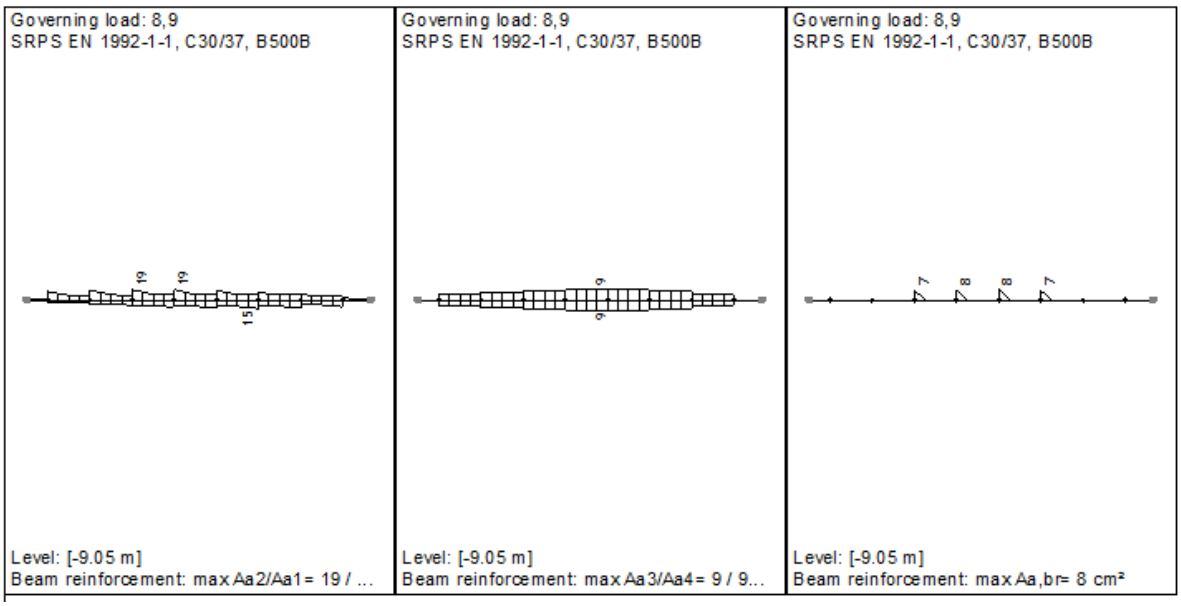
27Φ28/7.5 (Aa = 166.05 cm2)

узенгије / stirrups

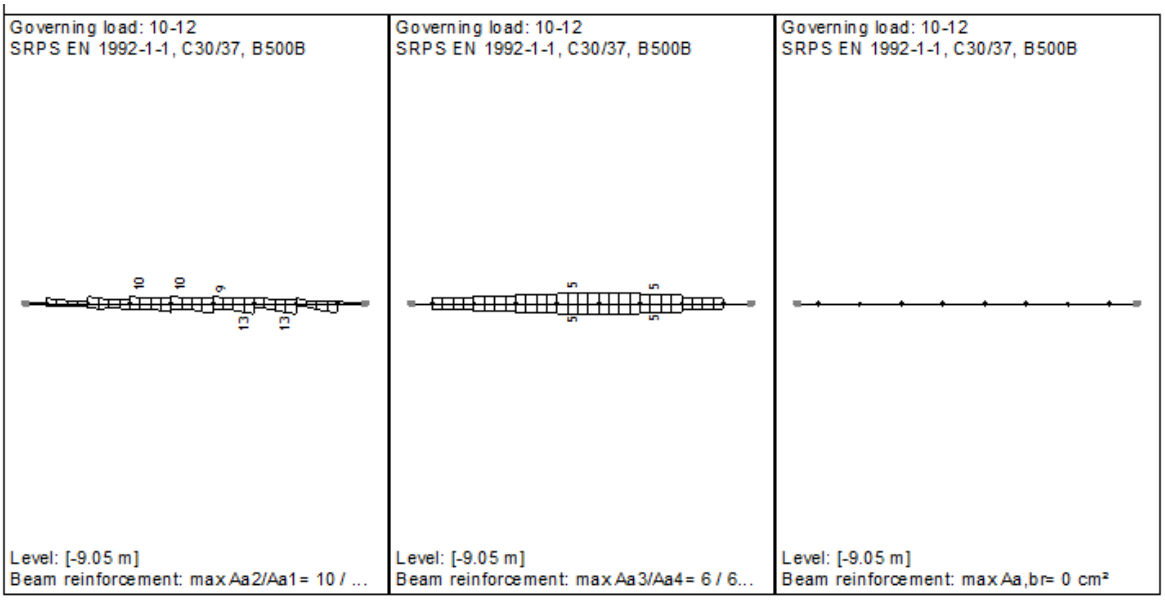
Φ14/15 (Aa = 10.26 cm2/m)

7.2.6. **Темељна греда /** Foundation beam

Comb 1



Comb 2



Усвојена арматура / Provided reinforcement

Подужна арматура / Longitudinal reinforcement

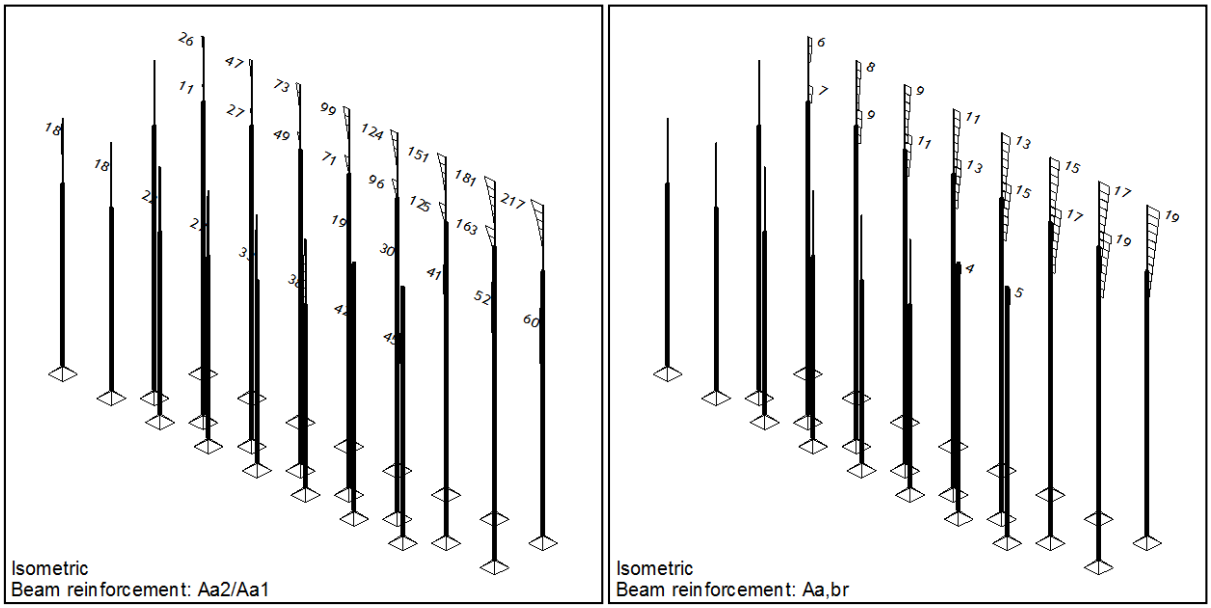
±12Φ20/15 (Aa = ±37.68 cm2)

узенгије / stirrups

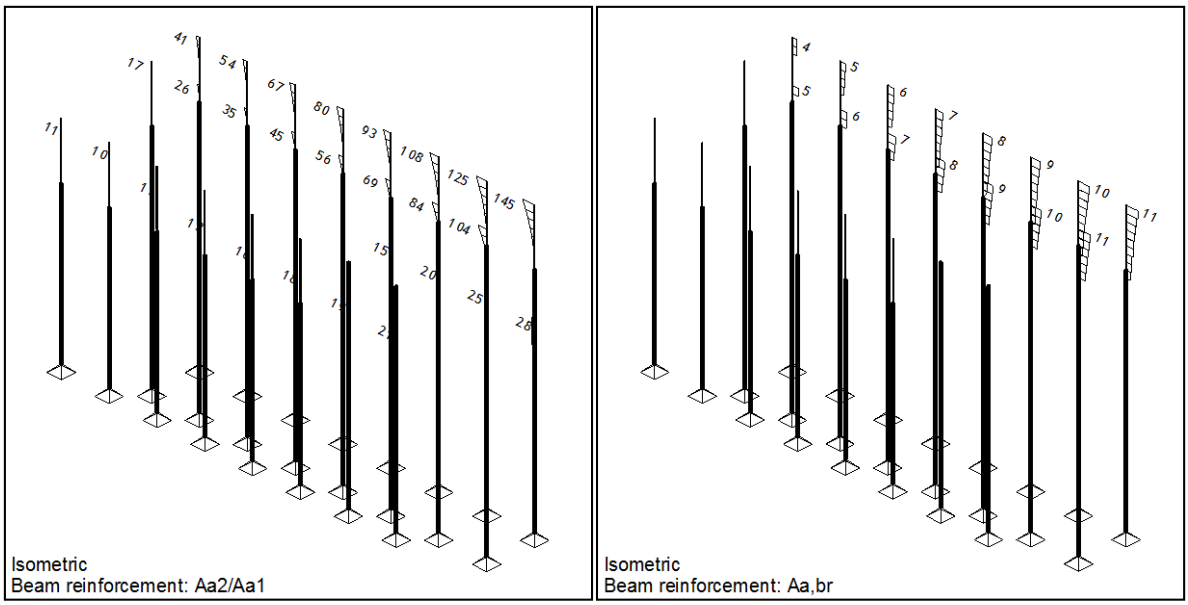
Φ16/15 (Aa = 13.40 cm2/m)

7.2.7. **Шипови /** Piles

Comb 1



Comb 2



Усвојена арматура / Provided reinforcement

Шипови испод темељне плоче / Piles under foundation slab

37Φ28/7.5 (Aa = 227.55 cm2) **Вертикална арматура** / Vertical reinforcement

Φ14/15 (Aa = 10.26 cm2/m) → **узенгије** / stirrups

Φ14/7.5 (Aa = 20.53 cm2/m) → **узенгије** / stirrups → **Горња зона** / Top zone 1.00 m

Шипови испод темељне греде / Piles unde foundation beam

20Φ20/15 (Aa = 62.80 cm2) **Вертикална арматура** / Vertical reinforcement

Φ12/15 (Aa = 7.54 cm2/m) → **узенгије** / stirrups

Φ12/10 (Aa = 11.30 cm2/m) → **узенгије** / stirrups → **Горња зона** / Top zone 1.00 m

Максимална сила у шипу / Maximal axial force

Шипови испод темељне плоче / Piles under foundation slab

Nmax = 5299 kN ULS → L = 20.0 m

Nmax = 3884 kN SLS

Шипови испод темељне греде / Piles unde foundation beam

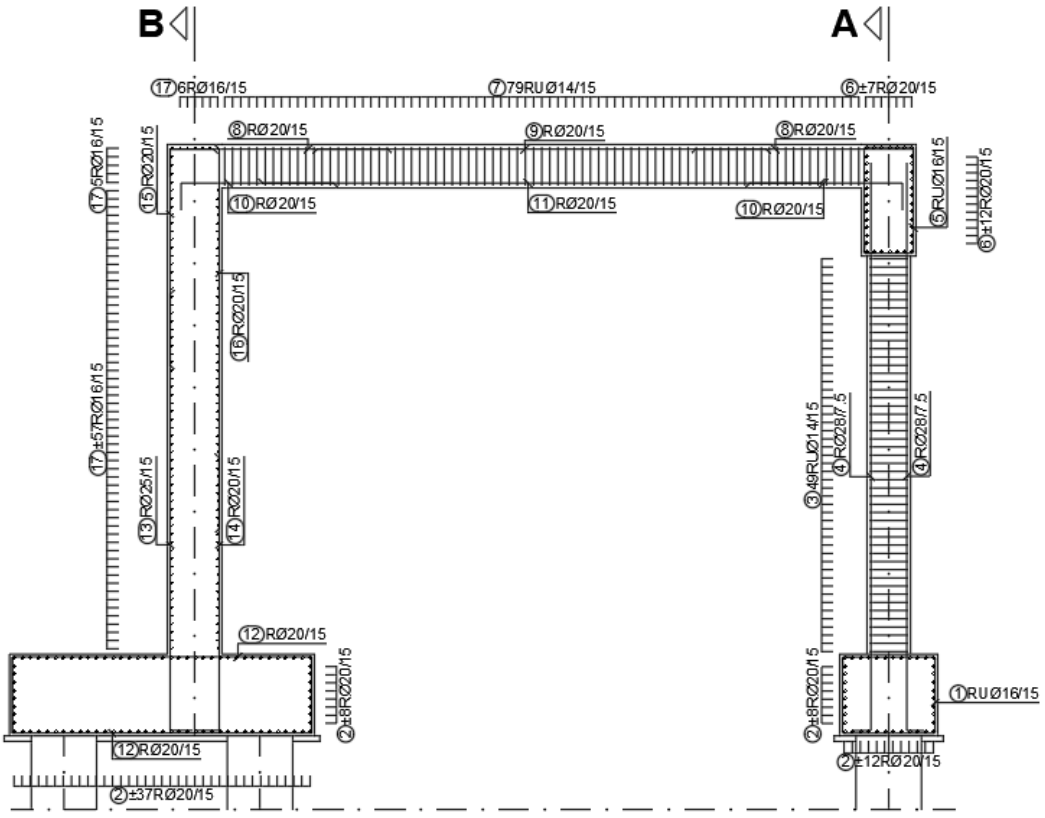
Nmax = 1701 kN ULS → L = 15.0 m

Nmax = 1256 kN SLS

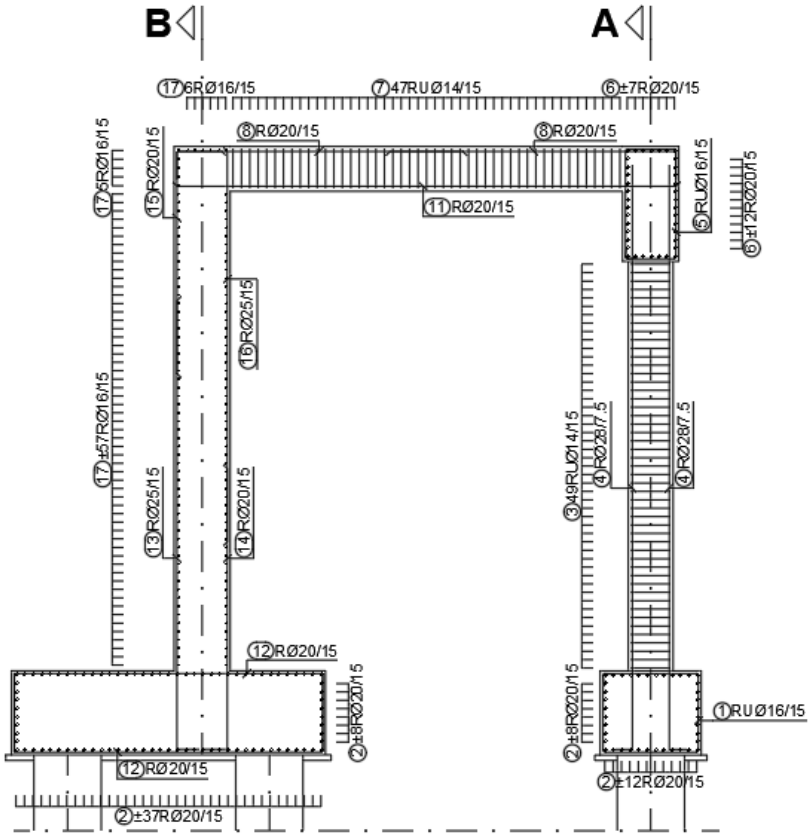
Frame	Length of pile	Diameter of pile	Analysis results, SRPS EN 1997-1, DA-2			Settlement of pile group
	L_s (m)	d (m)	R_s (kN)	R_b (kN)	R_c (kN)	s (mm)
2.2	15.0	1.2	4254.20	2513.85	6023.56	-
	16.0	1.2	4706.86	2617.69	6518.85	-
	16.95	1.2	5153.86	2716.34	7004.48	-
	18.0	1.2	5667.15	7063.44	11330.23	-
	19.0	1.2	6174.78	2929.22	8102.56	-
	20.0	1.2	6700.72	3033.06	8663.06	-
	21.0	1.2	7244.99	3136.91	9239.89	-
	22.0	1.2	7807.58	3240.75	9833.01	-
	23.0	1.2	8388.48	3344.60	10442.44	-
	24.0	1.2	8987.71	3448.44	11068.18	-
	25.0	1.2	9605.26	3552.28	11710.22	-
	26.0	1.2	10235.27	3656.13	12363.34	-
	27.0	1.2	10865.64	3759.97	13016.80	-
	28.0	1.2	11496.02	3863.82	13670.25	-
	29.0	1.2	12126.39	3967.66	14323.70	-

СХЕМА АРМАТУРЕ / REINFORCEMENT SCHEME

Улаз / Entrance



Излаз / Exit



8. Контрола граничног стања носивости / Analysis at the serviceability limit state (SLS)

8.1. Улаз / Entrance

8.1.1. Контрола прслина / Crack check

8.1.1.1 Зид / Wall

Frame: H_2 - SRPS EN 1992-1-1
C30/37 (slab depth h=100.0 cm)
Top zone: B500A (a=6.0 cm)
Bottom zone: B500A (a=6.0 cm)

Elastic modulus of concrete	Eb(t0)=	31500	MPa
Tension strength under bending	fbzs=	2.90	MPa
Elastic modulus of reinforcement	Ea=	2.00e+5	MPa
Concrete creep coefficient	φ∞=	2.60	
Dilatation of concrete shrinkage	εs=	0.00	‰

Point 1
X=14 m; Y=13 m; Z=-9 m
Bottom zone
Ø20/15 α = 0°
Ø25/15 α = 90°

Direction 1: (α=-90°)

T = 0 Section with Fissure
Critical combination: 1.00xI+1.00xII+1.00xIII
N1 = -109.40 kN/m
M = 611.71 kNm/m

Coeff. of reinforcement adhesion	k1=	0.80	
Coefficient of strain distribution	k2=	0.50	
Coefficient of reinforcement cover	k3=	3.40	
Factor	k4=	0.42	
Effective area od concrete	Ac,ef=	1350.0	cm²
Effective percentage of reinf.	ρef=	2.18	%
Position of neutral axis	xn=	30.91	cm
Stress in tensioned reinforcement	σs=	218.5	MPa
Coeff. of reinf. adhesion	β1=	1.00	
Longlasting loading coeff.	β2=	0.60	
The equivalent bar diameter	Øeq=	25.00	mm
Cover to the longitudinal reinforcement	c=	47.50	mm
Reinforcement stress at fisure opening	σsr=	151.3	MPa
Factor	ζa=	0.60	
Relative average dilatation	εm=	0.66	‰
Maximum fissures spacing	**Sr,max=**	**35.63**	**cm**
Fissures Width	**ak(t0)=**	**0.23**	**mm**

T = ∞ Section with Fissure
Long-term Influences
Critical combination: 1.00xI+1.00xII+1.00xIII
N1 = -109.40 kN/m
M = 611.71 kNm/m
Short-term Influences
N1 = 0.00 kN/m
M = 0.00 kNm/m

Coeff. of reinforcement adhesion	k1=	0.80	
Coefficient of strain distribution	k2=	0.50	
Coefficient of reinforcement cover	k3=	3.40	
Factor	k4=	0.42	
Effective area od concrete	Ac,ef=	1350.0	cm²
Effective percentage of reinf.	ρef=	2.18	%
Position of neutral axis	xn=	13.98	cm
Stress in tensioned reinforcement	σs=	224.6	MPa
Coeff. of reinf. adhesion	β1=	1.00	
Longlasting loading coeff.	β2=	0.40	
The equivalent bar diameter	Øeq=	25.00	mm
Cover to the longitudinal reinforcement	c=	47.50	mm
Reinforcement stress at fisure opening	σsr=	151.3	MPa
Factor	ζa=	0.73	
Relative average dilatation	εm=	0.82	‰
Maximum fissures spacing	**Sr,max=**	**35.63**	**cm**
Fissures Width	**ak(t∞)=**	**0.29**	**mm**

Direction 2: (α=0°)

T = 0 Section without Fissure

T = ∞ Section without Fissure

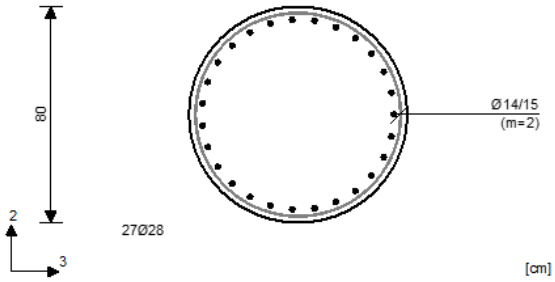
8.1.1.2 **Стуб /** Pier

Beam 1300-1086
SRPS EN 1992-1-1
C30/37
B500A

Elastic modulus of concrete	Eb(t0)=	31500	MPa
Tension strength under bending	fbzs=	2.90	MPa
Elastic modulus of reinforcement	Ea=	2.00e+5	MPa
Concrete creep coefficient	φ∞=	2.60	
Dilatation of concrete shrinkage	εs=	0.00	‰

Fissures: Inclined Bending

Section 1-1 x = 0.00m



T = 0 Section with Fissure
Critical combination: 1.00xI+1.00xII+1.00xIII
N1 = -462.18 kN
M3 = 204.04 kNm
M2 = 1317.01 kNm

Coeff. of reinforcement adhesion	k1=	0.80	
Coefficient of strain distribution	k2=	0.50	
Coefficient of reinforcement cover	k3=	3.40	
Factor	k4=	0.42	
Effective area od concrete	Ac,ef=	808.0	cm²
Effective percentage of reinf.	ρef=	6.10	%
Position of neutral axis	xn=	12.26	cm
Stress in tensioned reinforcement	σs=	354.1	MPa
Coeff. of reinf. adhesion	β1=	1.00	
Longlasting loading coeff.	β2=	0.60	
The equivalent bar diameter	Øeq=	28.00	mm
Cover to the longitudinal reinforcement	c=	34.00	mm
Reinforcement stress at fisure opening	σsr=	65.98	MPa
Factor	ζa=	0.89	
Relative average dilatation	εm=	1.57	‰
Maximum fissures spacing	**Sr,max=**	**19.37**	**cm**
Fissures Width	**ak(t0)=**	**0.30**	**mm**

T = ∞ Section with Fissure
Long-term Influences
Critical combination: 1.00xI+1.00xII+1.00xIII
N1 = -462.18 kN
M3 = 204.04 kNm
M2 = 1317.01 kNm
Short-term Influences
N1 = 0.00 kN
M3 = 0.00 kNm
M2 = 0.00 kNm

Coeff. of reinforcement adhesion	k1=	0.80	
Coefficient of strain distribution	k2=	0.50	
Coefficient of reinforcement cover	k3=	3.40	
Factor	k4=	0.42	
Effective area od concrete	Ac,ef=	644.1	cm²
Effective percentage of reinf.	ρef=	6.69	%
Position of neutral axis	xn=	4.60	cm
Stress in tensioned reinforcement	σs=	390.2	MPa
Coeff. of reinf. adhesion	β1=	1.00	
Longlasting loading coeff.	β2=	0.40	
The equivalent bar diameter	Øeq=	28.00	mm
Cover to the longitudinal reinforcement	c=	34.00	mm
Reinforcement stress at fisure opening	σsr=	61.75	MPa
Factor	ζa=	0.94	
Relative average dilatation	εm=	1.83	‰
Maximum fissures spacing	**Sr,max=**	**18.67**	**cm**
Fissures Width	**ak(t∞)=**	**0.34**	**mm**

8.1.2. **Контрола замора /** Fatigue check

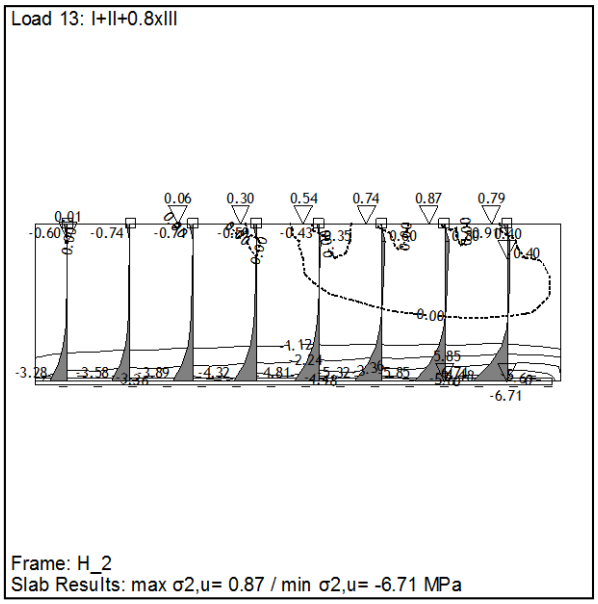
8.1.2.1 **Зид / Wall**

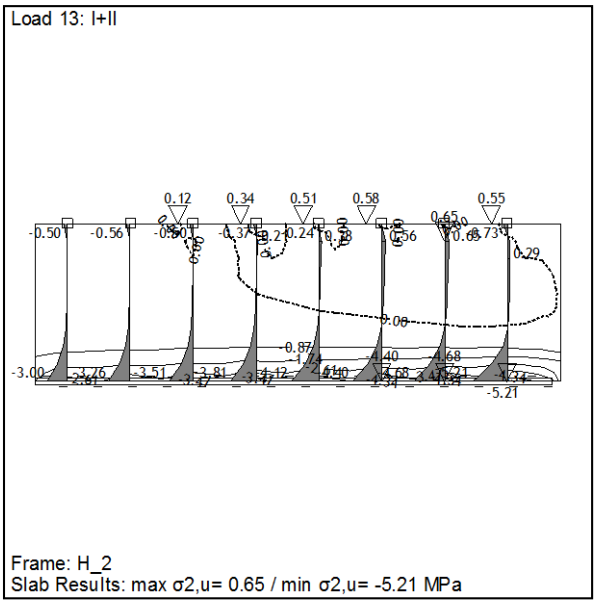
$\sigma_{c,max} / f_{cd,fat} \leq 0,5 + 0,45 * \sigma_{c,min} / f_{cd,fat} \leq 0,9$

σc,max – **Максимални ивични притисак** / Maximum edge pressure

σc,min – **Минимални ивични притисак** / Минимум edge pressure

$f_{cd,fat} = \beta_{cc}(t_0) * f_{cd} = 0,82 * 30 / 1,5 = 16,4 \text{ N/mm}^2$





σc,max = 6.71 Mpa

σc,min = 5.21 MPa

6.71 / 16,4 = 0,41 ≤ 0,5 + 0,45 * 5.21 / 16,4 = 0,64 ≤ 0,9

8.2. **Излаз** / Exit

8.2.1. **Контрола прслина / Crack check**

8.2.1.1 **Зид /** Wall

Frame: H_2 - SRPS EN 1992-1-1

C30/37 (slab depth h=100.0 cm)
Top zone: B500A (a=6.0 cm)
Bottom zone: B500A (a=6.0 cm)

Elastic modulus of concrete	Eb(t0)=	31500 MPa
Tension strength under bending	fbzs=	2.90 MPa
Elastic modulus of reinforcement	Ea=	2.00e+5 MPa
Concrete creep coefficient	φ^{∞}=	2.60
Dilatation of concrete shrinkage	ε_s=	0.00 ‰

Point 1
X=14.40 m; Y=12.75 m; Z=-9.05 m
Top zone
Ø16/15 α = 0°
Ø25/15 α = 90°
Bottom zone
Ø16/15 α = 0°
Ø25/15 α = 90°

Direction 1: (α=0°)

T = 0 Section without Fissure

T = ∞ Section without Fissure

Direction 2: (α=90°)

T = 0 Section with Fissure
Critical combination: 1.00xI+1.00xII+1.00xIII
N1 = -70.16 kN/m
M = 521.11 kNm/m

Coeff. of reinforcement adhesion	k1=	0.80
Coefficient of strain distribution	k2=	0.50
Coefficient of reinforcement cover	k3=	3.40
Factor	k4=	0.42
Effective area od concrete	$A_{c,ef}$=	1350.0 cm²
Effective percentage of reinf.	ρ_{ef}=	2.18 %
Position of neutral axis	xn=	32.24 cm
Stress in tensioned reinforcement	σ_s=	189.0 MPa
Coeff. of reinf. adhesion	β1=	1.00
Longlasting loading coeff.	β2=	0.60
The equivalent bar diameter	$Ø_{eq}$=	25.00 mm
Cover to the longitudinal reinforcement	c=	47.50 mm
Reinforcement stress at fisure opening	σ_{sr}=	151.3 MPa
Factor	ζ_a=	0.60
Relative average dilatation	ε_m=	0.57 ‰
Maximum fissures spacing	**Sr,max=**	**35.63 cm**
Fissures Width	**a_k(t0)=**	**0.20 mm**

T = ∞ Section with Fissure
Long-term Influences
Critical combination: 1.00xI+1.00xII+1.00xIII
N1 = -70.16 kN/m
M = 521.11 kNm/m
Short-term Influences
N1 = 0.00 kN/m
M = 0.00 kNm/m

Coeff. of reinforcement adhesion	k1=	0.80
Coefficient of strain distribution	k2=	0.50
Coefficient of reinforcement cover	k3=	3.40
Factor	k4=	0.42
Effective area od concrete	$A_{c,ef}$=	1350.0 cm²
Effective percentage of reinf.	ρ_{ef}=	2.18 %
Position of neutral axis	xn=	20.26 cm
Stress in tensioned reinforcement	σ_s=	191.8 MPa
Coeff. of reinf. adhesion	β1=	1.00
Longlasting loading coeff.	β2=	0.40
The equivalent bar diameter	$Ø_{eq}$=	25.00 mm
Cover to the longitudinal reinforcement	c=	47.50 mm
Reinforcement stress at fisure opening	σ_{sr}=	151.3 MPa
Factor	ζ_a=	0.68
Relative average dilatation	ε_m=	0.66 ‰
Maximum fissures spacing	**Sr,max=**	**35.63 cm**
Fissures Width	**a_k(t∞)=**	**0.23 mm**

8.2.1.2 **Стуб /** Pier

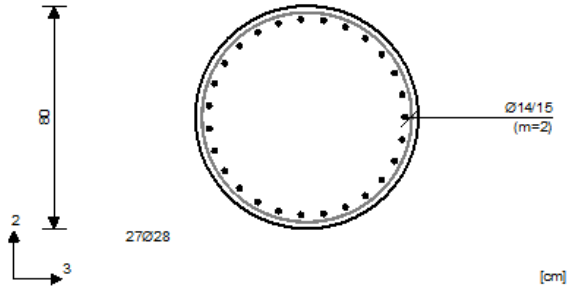
Beam 1322-1148

SRPS EN 1992-1-1
C40/50
B500A

Elastic modulus of concrete	Eb(t0)=	35000 MPa
Tension strength under bending	fbzs=	3.50 MPa
Elastic modulus of reinforcement	Ea=	2.00e+5 MPa
Concrete creep coefficient	φ∞=	2.60
Dilatation of concrete shrinkage	ε_s=	0.00 ‰

Fissures: Inclined Bending

Section 1-1 x = 0.00m



T = 0 Section with Fissure
Critical combination: 1.00xI+1.00xII+1.00xIII
N1 = -578.07 kN
M3 = 262.01 kNm
M2 = 1431.13 kNm

Coeff. of reinforcement adhesion	k1=	0.80
Coefficient of strain distribution	k2=	0.50
Coefficient of reinforcement cover	k3=	3.40
Factor	k4=	0.42
Effective area od concrete	$A_{c,ef}$=	817.5 cm²
Effective percentage of reinf.	ρ_{ef}=	5.27 %
Position of neutral axis	xn=	12.69 cm
Stress in tensioned reinforcement	σ_s=	378.4 MPa
Coeff. of reinf. adhesion	β1=	1.00
Longlasting loading coeff.	β2=	0.60
The equivalent bar diameter	$Ø_{eq}$=	28.00 mm
Cover to the longitudinal reinforcement	c=	34.00 mm
Reinforcement stress at fisure opening	σ_{sr}=	86.38 MPa
Factor	ζ_a=	0.86
Relative average dilatation	ε_m=	1.63 ‰
Maximum fissures spacing	**Sr,max=**	**20.59 cm**
Fissures Width	**a_k(t0)=**	**0.34 mm**

T = ∞ Section with Fissure
Long-term Influences
Critical combination: 1.00xI+1.00xII+1.00xIII
N1 = -578.07 kN
M3 = 262.01 kNm
M2 = 1431.13 kNm
Short-term Influences
N1 = 0.00 kN
M3 = 0.00 kNm
M2 = 0.00 kNm

Coeff. of reinforcement adhesion	k1=	0.80
Coefficient of strain distribution	k2=	0.50
Coefficient of reinforcement cover	k3=	3.40
Factor	k4=	0.42
Effective area od concrete	$A_{c,ef}$=	648.0 cm²
Effective percentage of reinf.	ρ_{ef}=	6.65 %
Position of neutral axis	xn=	4.79 cm
Stress in tensioned reinforcement	σ_s=	418.6 MPa
Coeff. of reinf. adhesion	β1=	1.00
Longlasting loading coeff.	β2=	0.40
The equivalent bar diameter	$Ø_{eq}$=	28.00 mm
Cover to the longitudinal reinforcement	c=	34.00 mm
Reinforcement stress at fisure opening	σ_{sr}=	72.62 MPa
Factor	ζ_a=	0.93
Relative average dilatation	ε_m=	1.95 ‰
Maximum fissures spacing	**Sr,max=**	**18.72 cm**
Fissures Width	**a_k(t∞)=**	**0.36 mm**

8.2.2. **Контрола замора /** Fatigue check

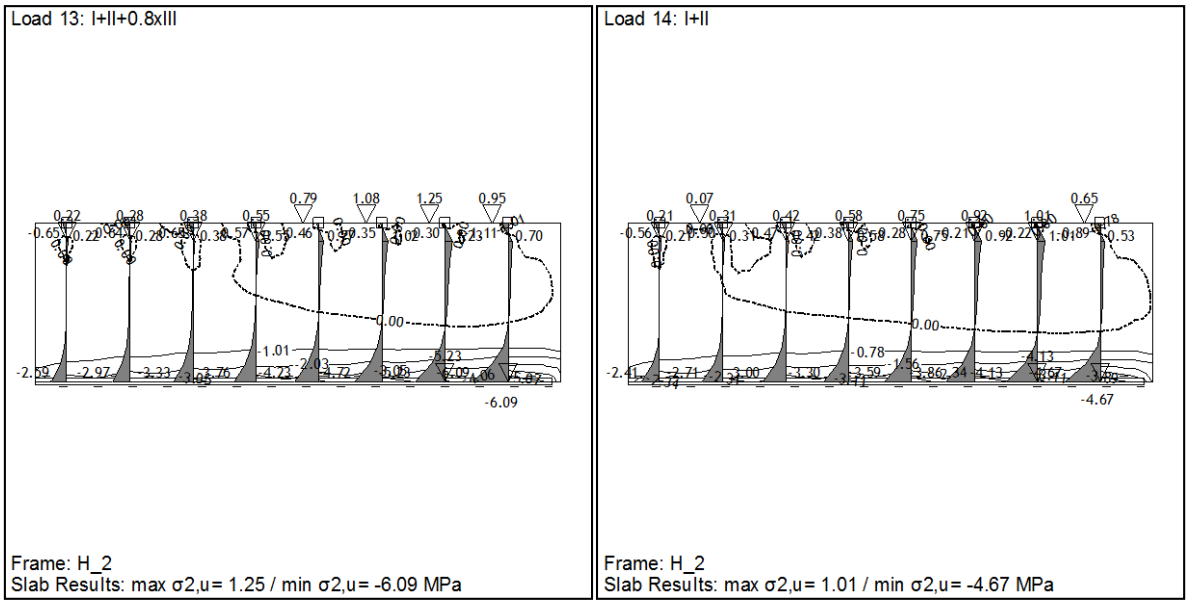
8.2.2.1. **Зид / Wall**

$\sigma_{c,max} / f_{cd,fat} \leq 0,5 + 0,45 * \sigma_{c,min} / f_{cd,fat} \leq 0,9$

σc,max – **Максимални ивични притисак** / Maximum edge pressure

σc,min – **Минимални ивични притисак** / Минимум edge pressure

$f_{cd,fat} = \beta_{cc}(t_0) * f_{cd} = 0,82 * 30 / 1,5 = 16,4\ N/mm^2$



σc,max = 6.09 Mpa

σc,min = 4.67 MPa

6.09 / 16,4 = 0,37 ≤ 0,5 + 0,45 * 4.67 / 16,4 = 0,63 ≤ 0,9

2/1.1.3.2.6.2 ПРОРАЧУН СТАБИЛНОСТИ

АНАЛИЗА СТАБИЛНОСТИ / STABILITY ANALISYS

ПОТПОРНИ ЗИДОВИ УЗ ГАЛЕРИЈУ НА КМ 78+377

RETAINING WALLS ADJACENT TO GALLERY AT KM 78+377

1.1. Statičko tretiranje konstrukcije i analiza rezultata proračuna

Статички прорачун је формиран на линијском моделу. Анализирани су утицаји сопствене тежине, притиска тла, оптерећења од воза. Одређивање притиска земље засновано је на методи граничних вредности по Coulomb-у. Контрола стабилности зида урађена је у складу са EN-1997 пројектни приступ 2.

Сеизмичка анализа урађена је у складу са Еурокодом 8: EN 1998-1:2004 i EN 1998-5:2004. Активни притисак тла срачунат је методом Monobe-Okambe.

У ту сврху одређене су вредности коефицијента хоризонталног убрзања:

$$Kh=\alpha*S/R$$

где је:

$$\alpha= \alpha_g/g= \alpha_g /9.81$$

α_g – пројектно површинско убрзање на тлу типа A (фактор значаја γ_1=1).

g – је убрзање земљине теже 9.81m/s^2

S – је фактор тла преузет из табеле (EN 1998-1:2004) за еластични спектар одговора tip 1.

Tip tla	S
A	1.0
B	1.2
C	1.15
D	1.35
E	1.4

R – је фактор за прорачун хоризонталног сеизмичког коефицијента. У случају АБ зида једнак је 1.

и коефицијента вертикалног убрзања:

Kv= ± 0.5Kh (за еластични спектар одговора тип 1)

На основу закључака из геотехничког елабората и горе наведених образаца креирана је табела са вредностима коефицијената хоризонталног и вертикалног убрзања:

Геотехничка средина	Тип тла	S	α	Kh	Kv
siSa	D	1.35	0.05	0.0675	0.0338

Извршена је и провера ивичних напона у тлу као и екцентрицитета (e_{maks}=0.17). Дозвољено оптерећење преузето је из геотехничког елабората.

Димензионисање како за гранично стање носивости тако и за гранично стање употребљивости обављено је за најнеповољнији случај оптерећења. Меродаван критеријум за усвајање потребне арматуре било је гранично стање прслина.

1.2. Рекапитулација улазних и излазних података

Геомеханички параметри тла

Вредности физичко-механичких параметара тла испод темеља:
γ = 20.3 kN/m3, ϕ = 26°, c = 12 kN/m2

Вредности физичко-механичких параметара засипа од песка:
γ = 20.0 kN/m3, ϕ = 30°, c = 0 kN/m2, δ=10°

Покретно оптерећење:

Воз: 63kN/m, L=3.0m

Стално оптерећење:

Туцанички застор: 15kN/m, L=5.6m

Коефицијенти сигурности:

Претурање: EN-1997 DA2
Клизање : EN-1997 DA2
Ексцентрицитет : 0.17

Излазни резултати (стална прорачунска ситуација):

Зид	Претурање (kNm/m)	Клизање (kN/m)	Максимални Ексцентрицитет (-)	Максимални напон у темељу (kPa)
(Кампада 1-2)	Mres=945.41 Movr=268.35 (28.4%)	Hres=251.64 Hact=197.56 (78.5%)	0.068	175.56
(Кампада 7)	Mres=883.22 Movr=211.09 (23.9%)	Hres=239.49 Hact=171.22 (71.5%)	0.042	165.38

где је:

Mres – момент отпора са урачунатим фактором сигурности.

Movr – моменат превртања који делује на зид

Hres – хоризонтална сила отпора са урачунатим фактором сигурности

Hact – хоризонтална сила која делује на зид.

За кампаде 3-6 стабилност на претурање и клизање није рачуната јер се зидови ослањају на шипове. Прорачун носивости шипова је део геотехничког елабората као и прорачун носивости тла испод темеља.

Силе које делују у центру темеља:

Зид	Случај оптерећења	Моменат [kNm/m]	Нормална сила [kN/m]	Хоризонтална сила [kN/m]	L [m]
	LC1	-4.96	918.13	368.96	
(Кампада 3)	LC2	95.00	720.24	368.96	7.2
	Service	-7.01	678.39	269.30	
	LC1	206.78	1087.95	451.04	
(Кампада 4)	LC2	329.94	858.29	451.04	7.2
	Service	145.17	803.34	328.71	
	LC1	158.73	1067.84	428.29	
(Кампада 5)	LC2	276.74	840.39	428.29	7.2
	Service	109.39	788.42	311.83	
	LC1	22.05	908.74	370.50	
(Кампада 6)	LC2	115.71	713.65	370.50	7.2
	Service	12.20	671.28	270.21	

Детаљан прорачун стабилности приказан за сталну и сеизмичку прорачунску ситуацију је у наставку.

Београд, Април 2021.

Одговорни пројектант:

Зоран Луковић, дипл.грађ.инж
лиценца бр.: 310 3032 03

Потпорни зидови уз галерију на km 78+377 пруге

Кампада 1-2

Retaining Walls adjacent to the gallery at km 78+377 of the railway line

Section 1-2

Cantilever wall analysis

Input data

Project

Task : Пројекат потпорних конструкција
Part : Деоница: Нови Сад - Суботица - Државна граница (Келебија)
Description : Потпорни зид на км 78+377 пруге - Кампаде 1-2
Date : 14.4.2021.

Settings

Standard - EN 1997 - PP2 - SRB

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : user-defined
Article 3.1.6 : $\alpha_{cc} = 0.85$

Wall analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Caquot-Kerisel
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Consider always vertical
Base key : The base key is considered as inclined footing bottom
Allowable eccentricity : 0.170
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

Partial factors on actions (A)					
Permanent design situation					
		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.35	[–]	1.00	[–]
Variable actions :	γ_Q =	1.50	[–]	0.00	[–]
Water load :	γ_w =	1.35	[–]		

Partial factors for resistances (R)			
Permanent design situation			
Partial factor on overturning :	γ_{Rv} =	1.40	[–]
Partial factor on sliding resistance :	γ_{Rh} =	1.10	[–]
Partial factor on bearing capacity :	γ_{Re} =	1.40	[–]

Partial factors for variable actions			
Permanent design situation			
Factor for combination value :	ψ_0 =	0.70	[–]
Factor for frequent value :	ψ_1 =	0.50	[–]
Factor for quasi-permanent value :	ψ_2 =	0.30	[–]

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Partial factors on actions (A)					
Seismic design situation					
		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.00	[–]	1.00	[–]
Variable actions :	γ_Q =	1.00	[–]	0.00	[–]
Water load :	γ_w =	1.00	[–]		

Partial factors for resistances (R)			
Seismic design situation			
Partial factor on overturning :	γ_{Rv} =	1.40	[–]
Partial factor on sliding resistance :	γ_{Rh} =	1.25	[–]
Partial factor on bearing capacity :	γ_{Re} =	1.40	[–]

Material of structure

Unit weight γ = 25.00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete: C 25/30
Cylinder compressive strength f_{ck} = 25.00 MPa
Tensile strength f_{ctm} = 2.60 MPa

Longitudinal steel: B500B
Yield strength f_{yk} = 500.00 MPa

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0.00	0.00
2	0.00	3.03
3	2.90	3.03
4	2.90	4.03
5	2.90	5.03
6	1.90	5.03
7	1.90	4.03
8	-1.30	4.03
9	-1.30	3.03
10	-1.00	3.03
11	-1.00	0.00

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 8.23 m^2.

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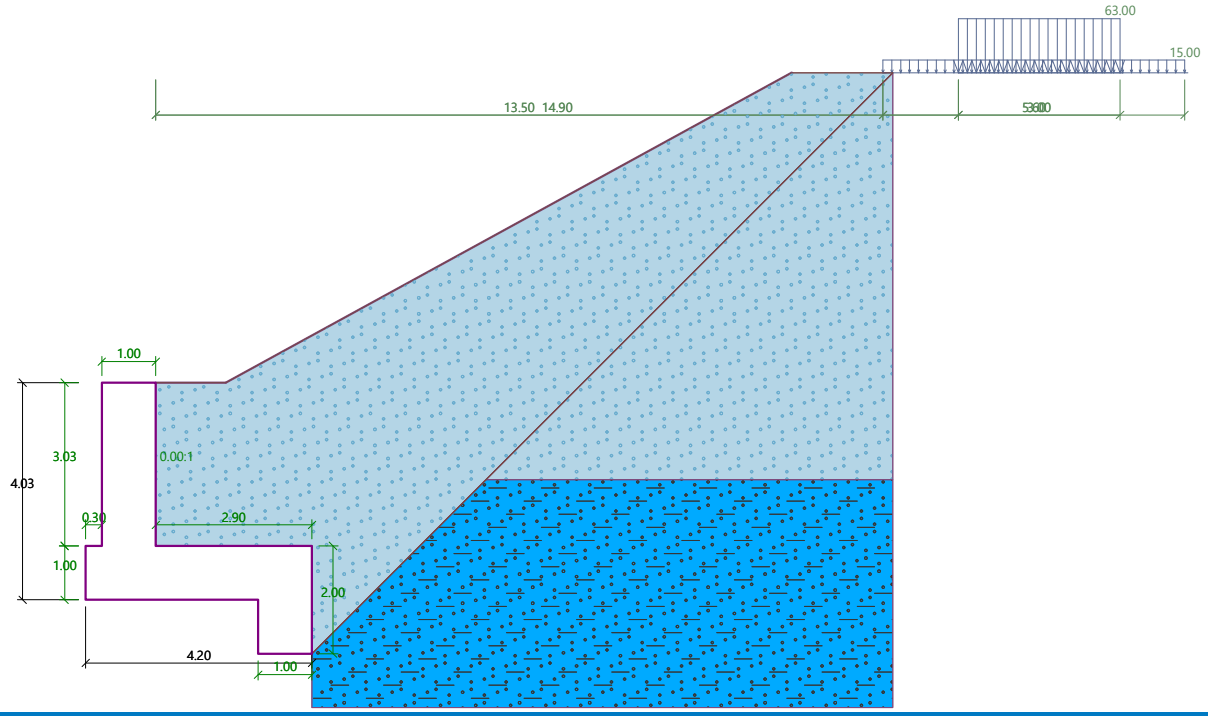
Name : Geometry	Stage - analysis : 1 - 0



Basic soil parameters

No.	Name	Pattern	ϕ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
1	Zasip		30.00	0.00	20.00	10.00	10.00
2	siSa		26.00	12.00	20.30	10.30	8.00
3	SaP		30.00	5.00	20.10	10.10	10.00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	ϕ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
1	Zasip		cohesive	-	0.20	-	-
2	siSa		cohesive	-	0.30	-	-
3	SaP		cohesive	-	0.28	-	-

Soil parameters

Zasip

Unit weight :	γ =	20.00 kN/m^3
Stress-state :		effective
Angle of internal friction :	ϕ_{ef} =	30.00 °
Cohesion of soil :	c_{ef} =	0.00 kPa
Angle of friction struc.-soil :	δ =	10.00 °
Soil :		cohesive
Poisson's ratio :	ν =	0.20

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Saturated unit weight : γ_{sat} = 20.00 kN/m^3

siSa

Unit weight : γ = 20.30 kN/m^3
Stress-state : effective
Angle of internal friction : ϕ_{ef} = 26.00 °
Cohesion of soil : c_{ef} = 12.00 kPa
Angle of friction struc.-soil : δ = 8.00 °
Soil : cohesive
Poisson's ratio : ν = 0.30
Saturated unit weight : γ_{sat} = 20.30 kN/m^3

SaP

Unit weight : γ = 20.10 kN/m^3
Stress-state : effective
Angle of internal friction : ϕ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 5.00 kPa
Angle of friction struc.-soil : δ = 10.00 °
Soil : cohesive
Poisson's ratio : ν = 0.28
Saturated unit weight : γ_{sat} = 20.10 kN/m^3

Backfill

Assigned soil : Zasip
Slope = 45.00 °

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	1.80	0.00 .. 1.80	Zasip	
2	7.60	1.80 .. 9.40	siSa	
3	-	9.40 .. ∞	siSa	

Foundation

Type of foundation : input parameters of contact base-soil

Parameters

Angle of friction base-soil ψ = 26.00 °
Cohesion base-soil a = 0.00 kPa

Terrain profile

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	1.30	0.00
3	11.80	-5.75
4	12.80	-5.75

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Origin [0,0] is located in upper right edge of construction.
Positive coordinate +z has downward direction.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
	new	change						
1	Yes		variable	63.00		14.90	3.00	on terrain
2	Yes		permanent	15.00		13.50	5.60	on terrain

No.	Name
1	Voz1
2	Tucanik

Resistance on front face of the structure

Resistance on front face of the structure is not considered.

Settings of the stage of construction

Design situation : permanent
The wall is free to move. Active earth pressure is therefore assumed.

Verification No. 1 (Stage of construction 1)

Active pressure behind the structure - partial results

Layer No.	Thickness [m]	α [°]	ϕ_d [°]	c_d [kPa]	γ [kN/m³]	δ_d [°]	K_a	Comment
1	0.88	0.00	30.00	0.00	20.00	30.00	0.643	
2	1.80	0.00	30.00	0.00	20.00	30.00	0.643	
3	1.23	0.00	30.00	0.00	20.00	30.00	0.643	
4	1.00	0.00	30.00	0.00	20.00	10.00	0.597	
5	0.31	0.00	30.00	0.00	20.00	10.00	0.597	
6	0.69	0.00	30.00	0.00	20.00	10.00	0.308	

Active pressure distribution behind the structure (without surcharge)

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.88	0.00	0.00	0.00	0.00	0.00
	0.00	17.52	0.00	11.27	9.76	5.63
2	0.00	17.52	0.00	11.27	9.76	5.63
	1.80	53.52	0.00	34.42	29.81	17.21
3	1.80	53.52	0.00	34.42	29.81	17.21
	3.03	78.12	0.00	50.24	43.51	25.12
4	3.03	78.12	0.00	46.62	45.92	8.10
	4.03	98.12	0.00	58.56	57.67	10.17
5	4.03	98.12	0.00	58.56	57.67	10.17
	4.34	104.28	0.00	62.23	61.29	10.81
6	4.34	104.28	0.00	62.23	61.29	10.81
	5.03	118.12	0.00	66.51	65.49	11.55

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Pressure distribution from surcharge - Voz1

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.88	0.00	0.00
2	0.00	0.00	0.00
3	0.00	0.00	0.00
4	1.80	0.00	0.00
5	2.05	0.00	0.00
6	2.05	8.73	5.04
7	3.03	8.19	4.73
8	3.03	9.66	1.70
9	4.03	9.09	1.60
10	4.34	8.91	1.57
11	5.03	8.51	1.50

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-1.12	205.75	1.82	1.000	1.000	1.350
Weight - earth wedge	0.00	-2.65	189.76	2.82	1.000	1.000	1.350
Active pressure	198.96	-0.95	69.16	4.20	1.350	1.350	1.350
Voz1	26.43	-0.48	7.97	4.20	0.000	1.500	1.500
Tucanik	11.41	-0.87	4.08	4.20	1.350	1.350	1.350

Verification of complete wall

Check for overturning stability

Resisting moment M_{res} = 945.41 kNm/m

Overturning moment M_{ovr} = 268.35 kNm/m

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 251.64 kN/m

Active horizontal force H_{act} = 197.56 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 175.56 kPa

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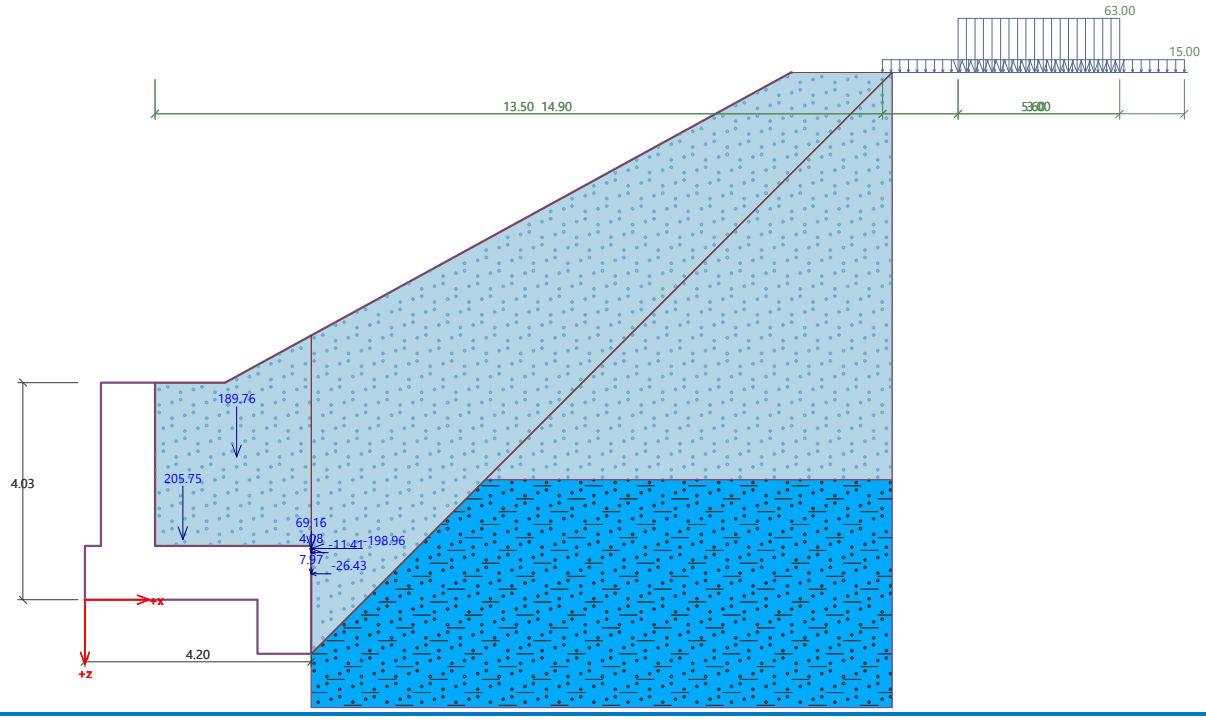
Name : Verification	Stage - analysis : 1 - 1



Bearing capacity of foundation soil (Stage of construction 1)

Design load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [–]	Stress [kPa]
1	111.55	702.20	152.19	0.038	175.56
2	124.98	555.90	186.08	0.054	141.63

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	81.61	518.60	110.24
2	72.43	510.85	112.03

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force $e = 0.054$
Maximum allowable eccentricity $e_{alw} = 0.170$

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Bearing capacity of foundation soil $R = 250.00$ kPa
Partial factor on bearing capacity $\gamma_{Rv} = 1.40$
Max. stress at footing bottom $\sigma = 175.56$ kPa
Bearing capacity of foundation soil $R_d = 178.57$ kPa

Bearing capacity of foundation soil is SATISFACTORY

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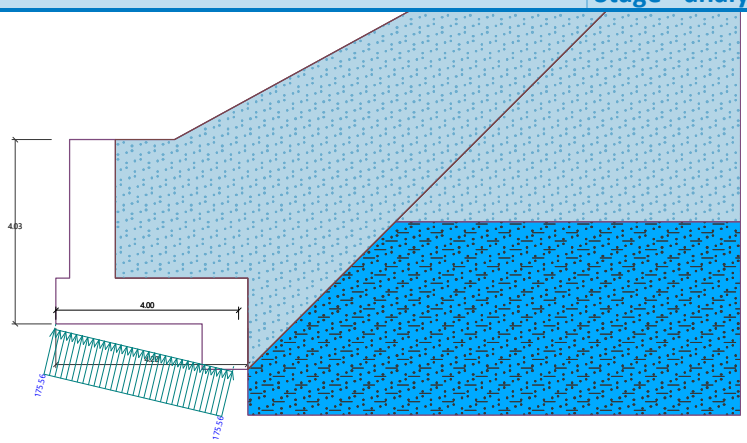
Overall verification - bearing capacity of found. soil is SATISFACTORY

Name : Bearing cap.	Stage - analysis : 1 - -1



Dimensioning No. 1 (Stage of construction 1)

Wall stem check - front reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-1.51	75.72	0.50	1.000	1.350	1.000
Pressure at rest	25.14	-0.96	0.00	1.00	1.350	1.000	1.350
Voz1	13.66	-1.48	0.00	1.00	1.500	0.000	1.500
Tucanik	6.16	-1.48	0.00	1.00	1.350	1.000	1.350

Wall stem check - front reinf.

Front reinforcement is not required.

Wall stem check - back reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-1.51	75.72	0.50	1.000	1.350	1.000
Pressure at rest	25.14	-0.96	0.00	1.00	1.350	1.000	1.350
Voz1	13.66	-1.48	0.00	1.00	1.500	0.000	1.500
Tucanik	6.16	-1.48	0.00	1.00	1.350	1.000	1.350

Wall stem check - back reinf.

Wall check at the construction joint 3.03 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 16.0 mm, cover 50.0 mm
Inputted reinforcement area = 1341.1 mm^2
Required reinforcement area = 1273.6 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.00 m

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Reinforcement ratio	ρ	=	0.14	%	>	0.14	%	= ρ_{min}
Position of neutral axis	x	=	0.05	m	<	0.58	m	= x_{max}
Ultimate shear force	V_{Rd}	=	291.05	kN	>	62.75	kN	= V_{Ed}
Ultimate moment	M_{Rd}	=	537.76	kNm	>	75.05	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

Wall heel check

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-0.50	72.50	2.75	1.350
Weight - earth wedge	0.00	-2.65	189.76	2.82	1.350
Active pressure	198.96	-0.95	69.16	4.20	1.350
Voz1	26.43	-0.48	7.97	4.20	1.500
Tucanik	11.41	-0.87	4.08	4.20	1.350
Contact stress	0.00	0.00	-450.79	2.67	1.000

Wall heel check

Reinforcement and dimensions of the cross-section
6.67 prof. 16.0 mm, cover 50.0 mm
Inputted reinforcement area = 1341.1 mm^2
Required reinforcement area = 1273.6 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.00 m

Reinforcement ratio	ρ	=	0.14	%	>	0.14	%	= ρ_{min}
Position of neutral axis	x	=	0.05	m	<	0.58	m	= x_{max}
Ultimate shear force	V_{Rd}	=	291.05	kN	>	14.09	kN	= V_{Ed}
Ultimate moment	M_{Rd}	=	537.26	kNm	>	235.21	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

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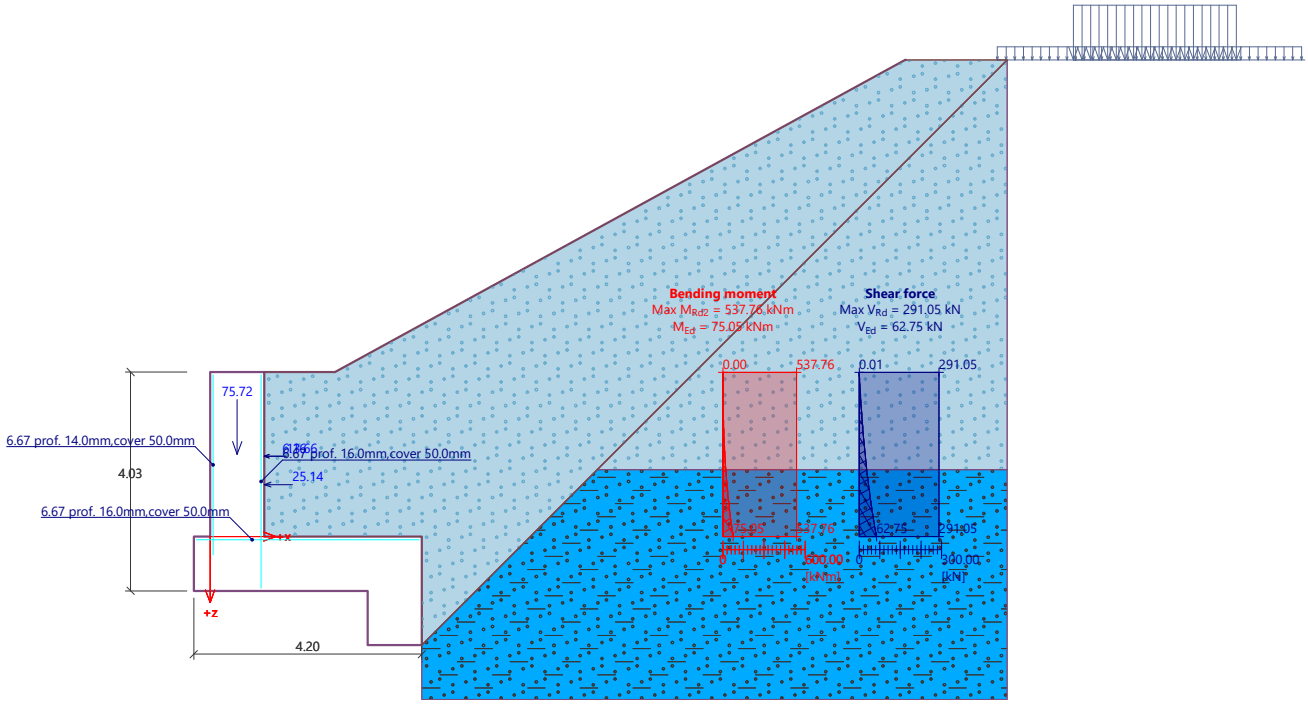
Name : Dimensioning	Stage - analysis : 1 - 1



Input data (Stage of construction 2)

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	1.80	0.00 .. 1.80	Zasip	
2	7.60	1.80 .. 9.40	siSa	
3	-	9.40 .. ∞	siSa	

Foundation

Type of foundation : input parameters of contact base-soil

Parameters

Angle of friction base-soil ψ = 26.00 °

Cohesion base-soil a = 0.00 kPa

Terrain profile

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	1.30	0.00
3	11.80	-5.75
4	12.80	-5.75

Origin [0,0] is located in upper right edge of construction.

Positive coordinate +z has downward direction.

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Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	No	No	variable	63.00		14.90	3.00	on terrain
2	No	No	permanent	15.00		13.50	5.60	on terrain

No.	Name
1	Voz1
2	Tucanik

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Zasip
Angle of friction struc.-soil $\delta = 0.00$ °
Soil thickness in front of structure $h = 1.00$ m

Terrain in front of structure is flat.

Earthquake

Factor of horizontal acceleration $K_h = 0.0675$
Factor of vertical acceleration $K_v = 0.0338$

Water below the GWT is restricted.

Settings of the stage of construction

Design situation : seismic
The wall is free to move. Active earth pressure is therefore assumed.

Verification No. 1 (Stage of construction 2)

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-1.12	205.75	1.82	1.000	1.000	1.000
Earthq.- constr.	13.89	-1.12	-6.95	1.82	1.000	1.000	1.000
FF resistance	-29.98	-0.33	0.00	0.00	1.000	1.000	1.000
Earthq.- face	1.19	-0.67	0.00	0.00	1.000	1.000	1.000
Weight - earth wedge	0.00	-2.65	189.76	2.82	1.000	1.000	1.000
Earthquake - soil wedge	12.81	-2.65	-6.41	2.82	1.000	1.000	1.000
Active pressure	198.96	-0.95	69.16	4.20	1.000	1.000	1.000
Earthq.- act.pressure	127.90	-2.99	68.85	4.20	1.000	1.000	1.000
Voz1	26.43	-0.48	7.97	4.20	0.000	0.700	0.700
Tucanik	11.41	-0.87	4.08	4.20	1.000	1.000	1.000

Verification of complete wall

Check for overturning stability
Resisting moment $M_{res} = 1053.14$ kNm/m
Overturning moment $M_{ovr} = 621.31$ kNm/m

Wall for overturning is SATISFACTORY

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Check for slip

Resisting horizontal force H_{res} = 233.16 kN/m

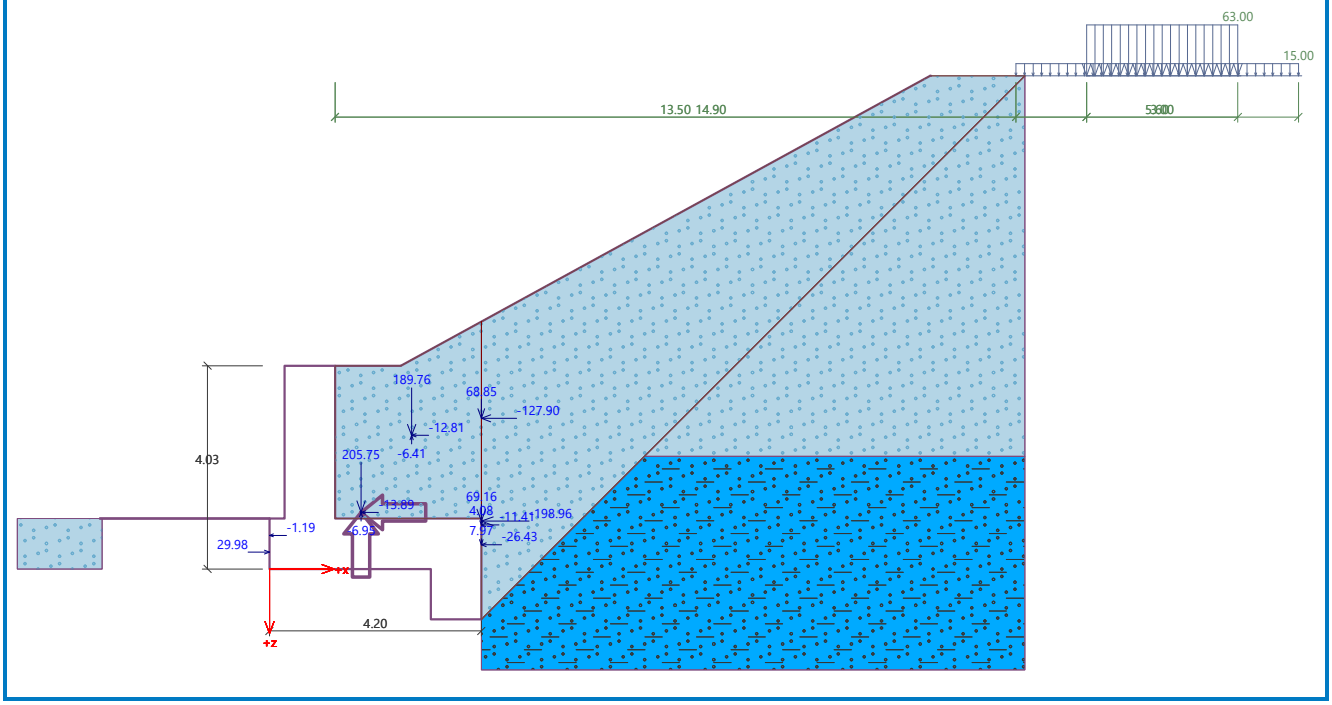
Active horizontal force H_{act} = 222.32 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 205.78 kPa

Name : Verification	Stage - analysis : 2 - 1



Warning - allowable range of input data exceeded during earthquake analysis!

The analysis is carried out with the modified value of terrain inclination β. (β=28.71°, β_{modif}=26.00°)

Bearing capacity of foundation soil (Stage of construction 2)

Design load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [–]	Stress [kPa]
1	422.33	597.56	206.63	0.168	205.78
2	415.90	592.13	207.88	0.168	202.54

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	425.08	601.72	213.37
2	415.90	593.97	215.17

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification

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Max. eccentricity of normal force e = 0.168
Maximum allowable eccentricity e_{alw} = 0.170

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Bearing capacity of foundation soil R = 400.00 kPa
Partial factor on bearing capacity γ_{Rv} = 1.40
Max. stress at footing bottom σ = 205.78 kPa
Bearing capacity of foundation soil R_d = 285.71 kPa

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Dimensioning No. 1 (Stage of construction 2)

Wall stem check - front reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-1.51	75.72	0.50	1.000	1.000	1.000
Earthq.- constr.	5.11	-1.51	-2.56	0.50	1.000	1.000	1.000
Pressure at rest	25.14	-0.96	0.00	1.00	1.000	1.000	1.000
Earthquake - pressure at rest	11.97	-1.51	0.00	1.00	1.000	1.000	1.000
Voz1	13.66	-1.48	0.00	1.00	0.700	0.000	0.700
Tucanik	6.16	-1.48	0.00	1.00	1.000	1.000	1.000

Wall stem check - front reinf.

Front reinforcement is not required.

Wall stem check - back reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-1.51	75.72	0.50	1.000	1.000	1.000
Earthq.- constr.	5.11	-1.51	-2.56	0.50	1.000	1.000	1.000
Pressure at rest	25.14	-0.96	0.00	1.00	1.000	1.000	1.000
Earthquake - pressure at rest	11.97	-1.51	0.00	1.00	1.000	1.000	1.000
Voz1	13.66	-1.48	0.00	1.00	0.700	0.000	0.700
Tucanik	6.16	-1.48	0.00	1.00	1.000	1.000	1.000

Wall stem check - back reinf.

Wall check at the construction joint 3.03 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 16.0 mm, cover 50.0 mm
Inputted reinforcement area = 1341.1 mm^2
Required reinforcement area = 1273.6 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.00 m

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Reinforcement ratio	ρ	=	0.14	%	>	0.14	%	= ρ_{min}
Position of neutral axis	x	=	0.05	m	<	0.58	m	= x_{max}
Ultimate shear force	V_{Rd}	=	291.05	kN	>	57.94	kN	= V_{Ed}
Ultimate moment	M_{Rd}	=	537.76	kNm	>	73.15	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

Wall heel check

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-0.50	72.50	2.75	1.000
Weight - earth wedge	0.00	-2.65	189.76	2.82	1.000
Active pressure	198.96	-0.95	69.16	4.20	1.000
Voz1	26.43	-0.48	7.97	4.20	0.700
Tucanik	11.41	-0.87	4.08	4.20	1.000
Contact stress	0.00	0.00	-283.65	2.26	1.000

Wall heel check

Reinforcement and dimensions of the cross-section
6.67 prof. 16.0 mm, cover 50.0 mm
Inputted reinforcement area = 1341.1 mm^2
Required reinforcement area = 1273.6 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.00 m

Reinforcement ratio	ρ	=	0.14	%	>	0.14	%	= ρ_{min}
Position of neutral axis	x	=	0.05	m	<	0.58	m	= x_{max}
Ultimate shear force	V_{Rd}	=	291.05	kN	>	57.43	kN	= V_{Ed}
Ultimate moment	M_{Rd}	=	537.26	kNm	>	349.43	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

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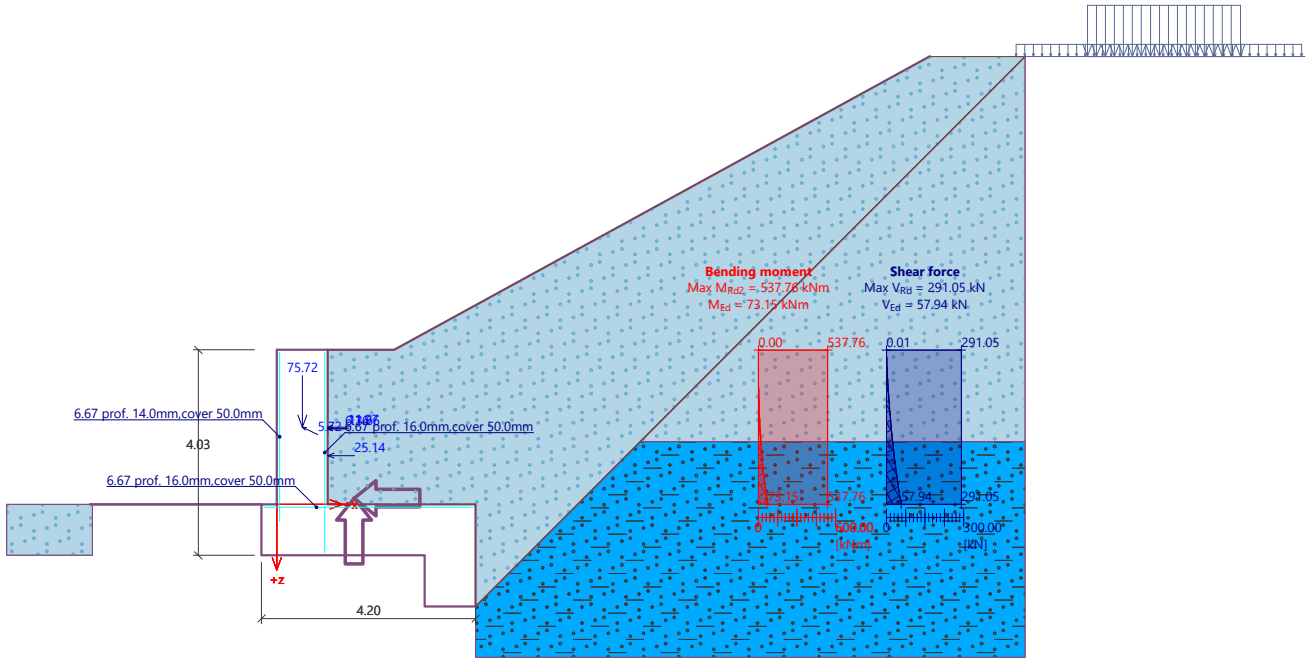
Name : Dimensioning	Stage - analysis : 2 - 1



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Потпорни зидови уз галерију на km 78+377 пруге

Кампада 3

Retaining Walls adjacent to the gallery at km 78+377 of the railway line

Section 3

Cantilever wall analysis

Input data

Project

Task : Пројекат потпорних конструкција
Part : Деоница: Нови Сад - Суботица - Државна граница (Келебија)
Description : Потпорни зид на км 78+399 пруге - Кампада 3
Date : 14.4.2021.

Settings

Standard - EN 1997 - PP2 - SRB

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : user-defined
Article 3.1.6 : $\alpha_{cc} = 0.85$

Wall analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Caquot-Kerisel
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Consider always vertical
Base key : The base key is considered as inclined footing bottom
Allowable eccentricity : 0.170
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

Partial factors on actions (A)					
Permanent design situation					
		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.35	[–]	1.00	[–]
Variable actions :	γ_Q =	1.50	[–]	0.00	[–]
Water load :	γ_w =	1.35	[–]		

Partial factors for resistances (R)			
Permanent design situation			
Partial factor on overturning :	γ_{Rv} =	1.40	[–]
Partial factor on sliding resistance :	γ_{Rh} =	1.10	[–]
Partial factor on bearing capacity :	γ_{Re} =	1.40	[–]

Partial factors for variable actions			
Permanent design situation			
Factor for combination value :	ψ_0 =	0.70	[–]
Factor for frequent value :	ψ_1 =	0.50	[–]
Factor for quasi-permanent value :	ψ_2 =	0.30	[–]

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Partial factors on actions (A)					
Seismic design situation					
		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.00	[–]	1.00	[–]
Variable actions :	γ_Q =	1.00	[–]	0.00	[–]
Water load :	γ_w =	1.00	[–]		

Partial factors for resistances (R)			
Seismic design situation			
Partial factor on overturning :	γ_{Rv} =	1.40	[–]
Partial factor on sliding resistance :	γ_{Rh} =	1.25	[–]
Partial factor on bearing capacity :	γ_{Re} =	1.40	[–]

Material of structure

Unit weight γ = 25.00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete: C 25/30
Cylinder compressive strength f_{ck} = 25.00 MPa
Tensile strength f_{ctm} = 2.60 MPa

Longitudinal steel: B500B
Yield strength f_{yk} = 500.00 MPa

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0.00	0.00
2	0.21	4.13
3	2.90	4.13
4	2.90	5.63
5	-2.70	5.63
6	-2.70	4.13
7	-1.00	4.13
8	-1.00	0.00

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 12.95 m^2.

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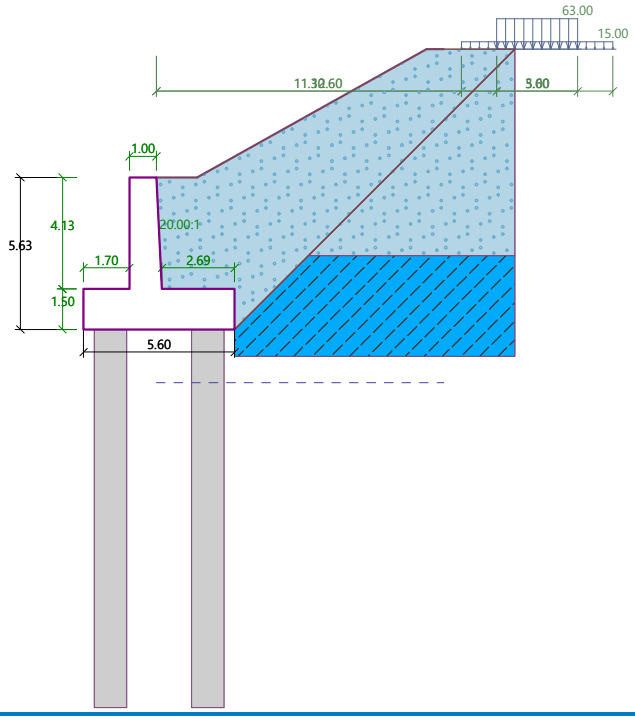
Name : Geometry	Stage - analysis : 1 - 0



Basic soil parameters

No.	Name	Pattern	ϕ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]	γ_{su} [kN/m³]	δ [°]
1	Zasip		30.00	0.00	20.00	10.00	10.00
2	siSa		26.00	12.00	20.30	10.30	8.00
3	SaP		30.00	5.00	20.10	10.10	10.00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	ϕ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
1	Zasip		cohesive	-	0.20	-	-
2	siSa		cohesive	-	0.30	-	-
3	SaP		cohesive	-	0.28	-	-

Soil parameters

Zasip

Unit weight : $\gamma = 20.00$ kN/m³
Stress-state : effective
Angle of internal friction : $\phi_{ef} = 30.00$ °
Cohesion of soil : $c_{ef} = 0.00$ kPa
Angle of friction struc.-soil : $\delta = 10.00$ °
Soil : cohesive
Poisson's ratio : $\nu = 0.20$

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Saturated unit weight : γ_{sat} = 20.00 kN/m^3

siSa

Unit weight : γ = 20.30 kN/m^3
Stress-state : effective
Angle of internal friction : ϕ_{ef} = 26.00 °
Cohesion of soil : c_{ef} = 12.00 kPa
Angle of friction struc.-soil : δ = 8.00 °
Soil : cohesive
Poisson's ratio : ν = 0.30
Saturated unit weight : γ_{sat} = 20.30 kN/m^3

SaP

Unit weight : γ = 20.10 kN/m^3
Stress-state : effective
Angle of internal friction : ϕ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 5.00 kPa
Angle of friction struc.-soil : δ = 10.00 °
Soil : cohesive
Poisson's ratio : ν = 0.28
Saturated unit weight : γ_{sat} = 20.10 kN/m^3

Backfill

Assigned soil : Zasip
Slope = 45.00 °

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	2.90	0.00 .. 2.90	Zasip	
2	7.60	2.90 .. 10.50	siSa	
3	14.30	10.50 .. 24.80	SaP	
4	-	24.80 .. ∞	SaP	

Foundation

Type of foundation : pile foundation
Unit weight γ = 25.00 kN/m^3

Geometry

Length l = 14.00 m
Offset d = 1.20 m
Diameter x = 0.40 m
Spacing b = 2.40 m

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Terrain profile

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	1.50	0.00
3	10.00	-4.75
4	11.00	-4.75

Origin [0,0] is located in upper right edge of construction.
Positive coordinate +z has downward direction.

Water influence

GWT behind the structure lies at a depth of 7.60 m
Uplift in foot. bottom due to different pressures is not considered.

Input surface surcharges

No.	Surcharge		Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
	new	change						
1	Yes		variable	63.00		12.60	3.00	on terrain
2	Yes		permanent	15.00		11.30	5.60	on terrain

No.	Name
1	Voz1
2	Tucanik

Resistance on front face of the structure

Resistance on front face of the structure is not considered.

Settings of the stage of construction

Design situation : permanent
The wall is free to move. Active earth pressure is therefore assumed.

Verification No. 1 (Stage of construction 1)

Active pressure behind the structure - partial results

Layer No.	Thickness [m]	α [°]	ϕ_d [°]	c_d [kPa]	γ [kN/m³]	δ_d [°]	K_a	Comment
1	0.78	0.00	30.00	0.00	20.00	30.00	0.682	
2	1.00	0.00	30.00	0.00	20.00	30.00	0.682	
3	1.28	0.00	30.00	0.00	20.00	30.00	0.682	
4	0.62	0.00	30.00	0.00	20.00	30.00	0.297	
5	1.23	0.00	30.00	0.00	20.00	30.00	0.297	
6	1.50	0.00	30.00	0.00	20.00	10.00	0.308	

Active pressure distribution behind the structure (without surcharge)

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.78	0.00	0.00	0.00	0.00	0.00
	0.00	15.61	0.00	10.65	9.22	5.32

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Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
2	0.00	15.61	0.00	10.65	9.22	5.32
	1.00	35.61	0.00	24.29	21.04	12.15
3	1.00	35.61	0.00	24.29	21.04	12.15
	2.28	61.27	0.00	41.80	36.20	20.90
4	2.28	61.27	0.00	41.80	36.20	20.90
	2.90	73.61	0.00	45.47	39.38	22.73
5	2.90	73.61	0.00	45.47	39.38	22.73
	4.13	98.21	0.00	52.78	45.71	26.39
6	4.13	98.21	0.00	54.78	53.95	9.51
	5.63	128.21	0.00	64.04	63.06	11.12

Water pressure distribution

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.78	0.00	0.00
2	0.00	0.00	0.00
3	1.00	0.00	0.00
4	2.28	0.00	0.00
5	2.90	0.00	0.00
6	4.13	0.00	0.00
7	5.63	0.00	0.00

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-1.72	323.78	2.61	1.000	1.000	1.350
Weight - earth wedge	0.00	-3.69	241.62	4.24	1.000	1.000	1.350
Active pressure	218.85	-2.22	91.16	5.60	1.350	1.350	1.350
Water pressure	0.00	-5.63	0.00	5.60	1.000	1.000	1.350
Voz1	36.01	-2.03	15.36	5.60	1.500	1.500	1.500
Tucanik	14.45	-2.40	6.47	5.60	1.350	1.350	1.350

Verification of complete wall

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 164.05 kPa

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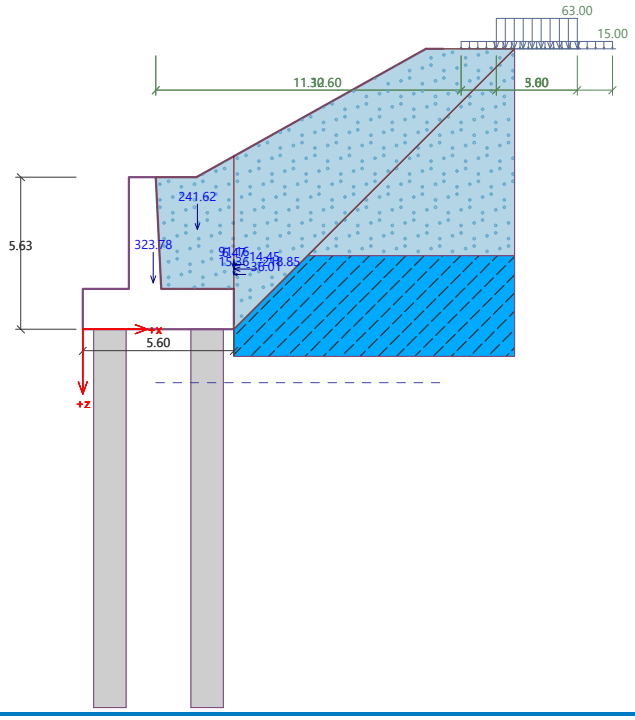
Name : Verification	Stage - analysis : 1 - 1



Bearing capacity of foundation soil (Stage of construction 1)

Forces acting in the center of pile foundation

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	-4.96	918.13	368.96
2	95.00	720.24	368.96

Normal forces acting in the center of pile foundation

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	-7.01	678.39	269.30

Input parameters for bearing capacity analysis

Pile spacing $s = 3.60$ m
Overall number of pile rows $n = 2$
Loading length $l = 7.20$ m

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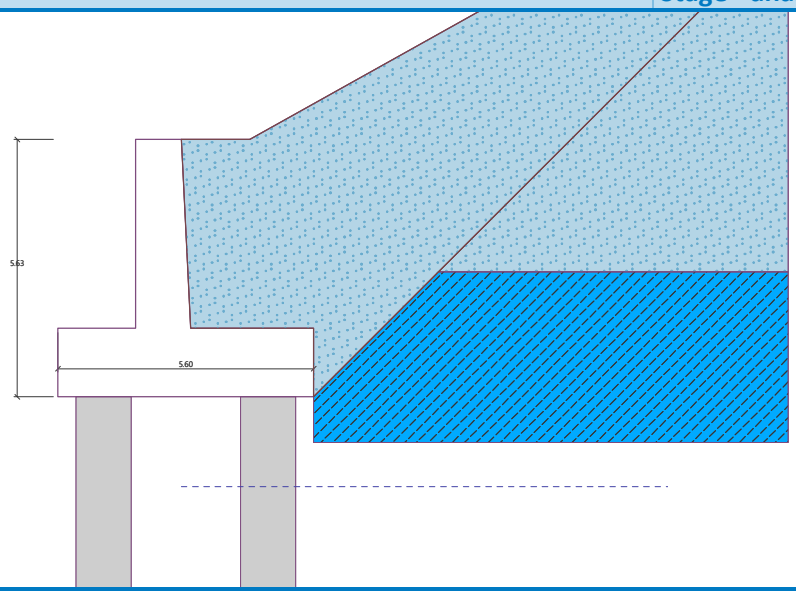
Name : Bearing cap.	Stage - analysis : 1 - -1



Verification of pile group

Verification No. 1

Dimensioning of piles - input data

Analysis carried out with an automatic selection of the most unfavorable LC.
Reinforcement designed for all piles in the group.

Verification of cross section in bending and compression:

Pile diameter: d=1.20m
Reinforcement - 18 pc bars 25.0 mm; cover 90.0 mm
Type of structure (reinforcement ratio) : pile
Reinforcement ratio $\rho = 0.781\ \% > 0.250\ \% = \rho_{min}$
Load : $N_{Ed} = 156.71$ kN (compression) ; $M_{Ed} = 1146.06$ kNm
Bearing capacity : $N_{Rd} = 251.31$ kN; $M_{Rd} = 1837.91$ kNm

Designed pile reinforcement is SATISFACTORY

Verification of cross section in shear:

Shear reinf. - 2 profile 12.0 mm; distance 150.0 mm
$A_{sw} = 1508.0\ mm^2$
Ultimate shear force: $V_{Rd} = 1416.18$ kN > 664.12 kN = V_{Ed}

Cross-section is SATISFACTORY.

only minimal shear reinforcement

Distribution of forces on construction

Depth [m]	Shear force Q [kN]	Bending moment M [kNm]	Normal force N [kN] (tension)	Normal force N [kN] (compression)
0.00	664.12	432.83	-465.74	-2446.54
1.40	432.46	430.62	-452.39	-2376.40
2.80	245.22	890.40	-424.77	-2231.29
4.20	100.46	1114.48	-396.27	-2081.62
5.60	37.42	1146.06	-365.29	-1918.87
7.00	134.01	1020.44	-329.26	-1729.62
8.40	184.94	792.12	-290.78	-1527.44

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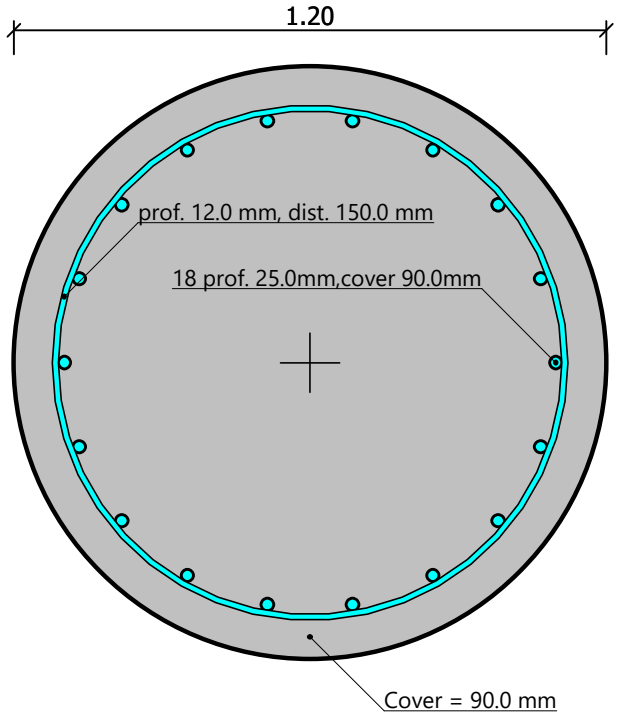
Depth [m]	Shear force Q [kN]	Bending moment M [kNm]	Normal force N [kN] (tension)	Normal force N [kN] (compression)
9.80	194.50	521.89	-252.37	-1325.71
11.20	165.80	265.35	-214.05	-1124.42
12.60	100.70	74.62	-175.81	-923.54
14.00	0.00	0.00	-156.71	-823.18

Reinforcement drawing



Pile verification

Vertical bear.cap. No.1 - Floating pile

Verification of pile bearing capacity according to NAVFAC DM 7.2 - partial results

Pile base bearing capacity:
The soil under the base is cohesionless
Coefficient of bearing capacity N_q = 10.00
Area of pile transverse cross-section A_p = 1.13E+00 m^2

Plie shaft resistance:

Depth [m]	Thickness [m]	c_{ud} [kPa]	α [–]	K [–]	δ [°]	σ_{or} [kPa]	R_{si} [kN]
0.00	-	-	-	-	-	-	-
1.97	1.97	-	-	1.17	19.50	20.00	55.98
1.97	-	-	-	-	-	-	-
4.87	2.90	-	-	1.17	19.50	54.93	226.38
4.87	-	-	-	-	-	-	-
14.00	9.13	-	-	1.28	22.50	115.97	1920.55

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Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out with automatic selection of the most unfavourable load cases.
Efficiency of pile group $\eta_g = 0.90$
Factor determining critical depth $k_{dc} = 24.00$

Verification of compressive pile:
Most unfavorable load case No. 1. (LC 1)
Pile skin bearing capacity R_s = 2202.91 kN
Pile base bearing capacity R_b = 1666.38 kN

Pile bearing capacity R_c = 3482.36 kN
Ultimate vertical force V_d = 2446.54 kN

$R_c = 3482.36$ kN > 2446.54 kN = V_d

Pile bearing capacity is SATISFACTORY

Dimensioning No. 1 (Stage of construction 1)

Wall stem check - front reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-2.00	113.87	0.55	1.350	1.350	1.000
Pressure at rest	48.95	-1.28	9.79	1.14	1.350	1.350	1.350
Water pressure	0.00	-4.13	0.00	1.00	1.000	1.000	1.000
Voz1	21.54	-2.01	4.31	1.11	1.500	1.500	1.500
Tucanik	9.64	-2.02	1.93	1.11	1.350	1.350	1.350

Wall stem check - front reinf. - V_{Ed}

Wall check at the construction joint 4.13 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1550.0 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.21 m

Ultimate shear force $V_{Rd} = 338.65$ kN > 111.40 kN = V_{Ed}
Cross-section is SATISFACTORY.

Wall stem check - front reinf. - M_{Ed}

Wall check at the construction joint 0.08 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1550.0 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.00 m

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Reinforcement ratio ρ = 0.22 % > 0.14 % = ρ_{min}
Position of neutral axis x = 0.07 m < 0.58 m = x_{max}
Ultimate moment M_{Rd} = 830.63 kNm > 0.01 kNm = M_{Ed}

Cross-section is SATISFACTORY.

Wall stem check - back reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-2.00	113.87	0.55	1.350	1.350	1.000
Pressure at rest	48.95	-1.28	9.79	1.14	1.350	1.350	1.350
Water pressure	0.00	-4.13	0.00	1.00	1.000	1.000	1.000
Voz1	21.54	-2.01	4.31	1.11	1.500	1.500	1.500
Tucanik	9.64	-2.02	1.93	1.11	1.350	1.350	1.350

Wall stem check - back reinf.

Wall check at the construction joint 4.13 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1550.0 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.21 m

Reinforcement ratio ρ = 0.18 % > 0.14 % = ρ_{min}
Position of neutral axis x = 0.07 m < 0.71 m = x_{max}
Ultimate shear force V_{Rd} = 338.65 kN > 111.40 kN = V_{Ed}
Ultimate moment M_{Rd} = 1015.02 kNm > 172.05 kNm = M_{Ed}

Cross-section is SATISFACTORY.

Wall jump check

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-1.72	323.78	2.61	1.350
Weight - earth wedge	0.00	-3.69	241.62	4.24	1.350
Active pressure	218.85	-2.22	91.16	5.60	1.350
Water pressure	0.00	-5.63	0.00	5.60	1.350
Voz1	36.01	-2.03	15.36	5.60	1.500
Tucanik	14.45	-2.40	6.47	5.60	1.350

Wall jump check

Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1946.9 mm^2

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Cross-section width = 1.00 m
Cross-section height = 1.50 m

Reinforcement ratio	ρ	=	0.15	%	>	0.14	%	=	ρ_{min}
Position of neutral axis	x	=	0.08	m	<	0.89	m	=	x_{max}
Ultimate shear force	V_{Rd}	=	405.28	kN	>	215.14	kN	=	V_{Ed}
Ultimate moment	M_{Rd}	=	1282.63	kNm	>	182.87	kNm	=	M_{Ed}

Cross-section is SATISFACTORY.

Wall heel check

Active pressure behind the structure - partial results

Layer No.	Thickness [m]	α [°]	ϕ_d [°]	c_d [kPa]	γ [kN/m³]	δ_d [°]	K_a	Comment
1	0.78	0.00	30.00	0.00	20.00	30.00	0.682	
2	1.00	0.00	30.00	0.00	20.00	30.00	0.682	
3	1.28	0.00	30.00	0.00	20.00	30.00	0.682	
4	0.62	0.00	30.00	0.00	20.00	30.00	0.297	
5	1.23	0.00	30.00	0.00	20.00	30.00	0.297	
6	1.50	0.00	30.00	0.00	20.00	10.00	0.308	

Active pressure distribution behind the structure (without surcharge)

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.78	0.00	0.00	0.00	0.00	0.00
	0.00	15.61	0.00	10.65	9.22	5.32
2	0.00	15.61	0.00	10.65	9.22	5.32
	1.00	35.61	0.00	24.29	21.04	12.15
3	1.00	35.61	0.00	24.29	21.04	12.15
	2.28	61.27	0.00	41.80	36.20	20.90
4	2.28	61.27	0.00	41.80	36.20	20.90
	2.90	73.61	0.00	45.47	39.38	22.73
5	2.90	73.61	0.00	45.47	39.38	22.73
	4.13	98.21	0.00	52.78	45.71	26.39
6	4.13	98.21	0.00	54.78	53.95	9.51
	5.63	128.21	0.00	64.04	63.06	11.12

Water pressure distribution

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.78	0.00	0.00
2	0.00	0.00	0.00
3	1.00	0.00	0.00
4	2.28	0.00	0.00
5	2.90	0.00	0.00
6	4.13	0.00	0.00

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Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
7	5.63	0.00	0.00

Pressure distribution from surcharge - Voz1

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.78	0.00	0.00
2	0.00	0.00	0.00
3	0.00	0.00	0.00
4	1.00	0.00	0.00
5	1.63	0.00	0.00
6	1.63	9.88	5.70
7	2.28	9.42	5.44
8	2.90	8.98	5.19
9	4.13	8.11	4.68
10	4.13	9.58	1.69
11	5.63	8.48	1.50

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-0.75	100.88	4.25	1.350
Weight - earth wedge	0.00	-3.69	241.62	4.24	1.350
Active pressure	218.85	-2.22	91.16	5.60	1.350
Voz1	36.01	-2.03	15.36	5.60	1.500
Tucanik	14.45	-2.40	6.47	5.60	1.350
Contact stress	0.00	0.00	-443.06	4.25	1.000

Wall heel check

Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1946.9 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.50 m

Reinforcement ratio	ρ	=	0.15	%	>	0.14	%	= ρ_{min}
Position of neutral axis	x	=	0.08	m	<	0.89	m	= x_{max}
Ultimate shear force	V_{Rd}	=	405.28	kN	>	174.15	kN	= V_{Ed}
Ultimate moment	M_{Rd}	=	1282.63	kNm	>	438.42	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

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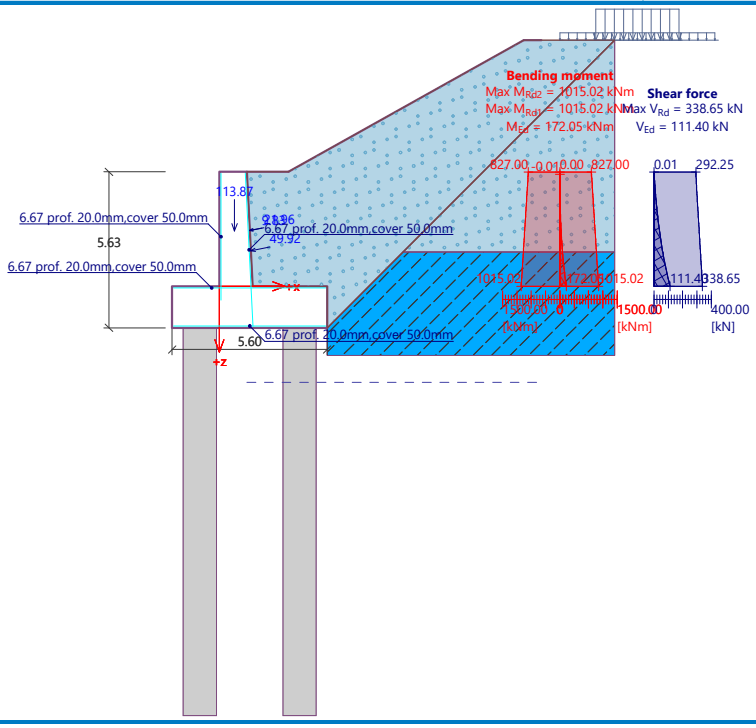
Name : Dimensioning	Stage - analysis : 1 - 1



Input data (Stage of construction 2)

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	2.90	0.00 .. 2.90	Zasip	
2	7.60	2.90 .. 10.50	siSa	
3	14.30	10.50 .. 24.80	SaP	
4	-	24.80 .. ∞	SaP	

Foundation

Type of foundation : pile foundation
Unit weight γ = 25.00 kN/m3

Geometry

Length l = 14.00 m
Offset d = 1.20 m
Diameter x = 0.40 m
Spacing b = 2.40 m

Terrain profile

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	1.50	0.00
3	10.00	-4.75

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No.	Coordinates x [m]	Depth z [m]
4	11.00	-4.75

Origin [0,0] is located in upper right edge of construction.
Positive coordinate +z has downward direction.

Water influence

GWT behind the structure lies at a depth of 7.60 m
Uplift in foot. bottom due to different pressures is not considered.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	No	No	variable	63.00		12.60	3.00	on terrain
2	No	No	permanent	15.00		11.30	5.60	on terrain

No.	Name
1	Voz1
2	Tucanik

Resistance on front face of the structure

Resistance on front face of the structure is not considered.

Earthquake

Factor of horizontal acceleration K_h = 0.0675
Factor of vertical acceleration K_v = 0.0338

Water below the GWT is restricted.

Settings of the stage of construction

Design situation : seismic
The wall is free to move. Active earth pressure is therefore assumed.

Verification No. 1 (Stage of construction 2)

Active pressure behind the structure - partial results

Layer No.	Thickness [m]	α [°]	ϕ_d [°]	c_d [kPa]	γ [kN/m³]	δ_d [°]	K_a	Comment
1	0.78	0.00	30.00	0.00	20.00	30.00	0.682	
2	1.00	0.00	30.00	0.00	20.00	30.00	0.682	
3	1.28	0.00	30.00	0.00	20.00	30.00	0.682	
4	0.62	0.00	30.00	0.00	20.00	30.00	0.297	
5	1.23	0.00	30.00	0.00	20.00	30.00	0.297	
6	1.50	0.00	30.00	0.00	20.00	10.00	0.308	

Active pressure distribution behind the structure (without surcharge)

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.78	0.00	0.00	0.00	0.00	0.00
	0.00	15.61	0.00	10.65	9.22	5.32

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Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
2	0.00	15.61	0.00	10.65	9.22	5.32
	1.00	35.61	0.00	24.29	21.04	12.15
3	1.00	35.61	0.00	24.29	21.04	12.15
	2.28	61.27	0.00	41.80	36.20	20.90
4	2.28	61.27	0.00	41.80	36.20	20.90
	2.90	73.61	0.00	45.47	39.38	22.73
5	2.90	73.61	0.00	45.47	39.38	22.73
	4.13	98.21	0.00	52.78	45.71	26.39
6	4.13	98.21	0.00	54.78	53.95	9.51
	5.63	128.21	0.00	64.04	63.06	11.12

Earthquake effects (active earth pressure) - partial results

Layer No.	Thickness [m]	ϕ_d [°]	β [°]	ψ [°]	K_a	K_{ae}	K_{ae}-K_a	Comment
1	0.78	30.00	29.20(26.00)	4.00	0.530	0.977	0.447	MODIFIED
2	1.00	30.00	29.20(26.00)	4.00	0.530	0.977	0.447	MODIFIED
3	1.28	30.00	29.20(26.00)	4.00	0.530	0.977	0.447	MODIFIED
4	0.62	30.00	29.20(26.00)	4.00	0.530	0.977	0.447	MODIFIED
5	1.23	30.00	29.20(26.00)	4.00	0.530	0.977	0.447	MODIFIED
6	1.50	30.00	29.20(26.00)	4.00	0.508	0.835	0.327	MODIFIED

Earthquake effects (active earth pressure)

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_D [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vertical comp. [kPa]
1	-0.78	0.00	123.87	55.35	47.93	27.67
	0.00	15.08	108.79	48.61	42.10	24.30
2	0.00	15.08	108.79	48.61	42.10	24.30
	1.00	34.40	89.47	39.97	34.62	19.99
3	1.00	34.40	89.47	39.97	34.62	19.99
	2.28	59.20	64.67	28.89	25.02	14.45
4	2.28	59.20	64.67	28.89	25.02	14.45
	2.90	71.12	52.75	23.57	20.41	11.79
5	2.90	71.12	52.75	23.57	20.41	11.79
	4.13	94.89	28.99	12.95	11.22	6.48
6	4.13	94.89	28.99	9.48	9.33	1.65
	5.63	123.87	0.00	0.00	0.00	0.00

Water pressure distribution

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.78	0.00	0.00
2	0.00	0.00	0.00

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Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
3	1.00	0.00	0.00
4	2.28	0.00	0.00
5	2.90	0.00	0.00
6	4.13	0.00	0.00
7	5.63	0.00	0.00

Pressure distribution from surcharge - Voz1

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.78	0.00	0.00
2	0.00	0.00	0.00
3	0.00	0.00	0.00
4	1.00	0.00	0.00
5	1.63	0.00	0.00
6	1.63	9.88	5.70
7	2.28	9.42	5.44
8	2.90	8.98	5.19
9	4.13	8.11	4.68
10	4.13	9.58	1.69
11	5.63	8.48	1.50

Pressure distribution from surcharge - Tucanik

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.78	0.00	0.00
2	0.00	0.00	0.00
3	0.00	0.00	0.00
4	0.88	0.00	0.00
5	0.88	3.29	1.90
6	1.00	3.27	1.89
7	1.63	3.16	1.83
8	2.28	3.05	1.76
9	2.90	2.95	1.70
10	4.13	2.74	1.58
11	4.13	3.24	0.57
12	5.63	2.97	0.52

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-1.72	323.78	2.61	1.000	1.000	1.000
Earthq.- constr.	21.86	-1.72	-10.94	2.61	1.000	1.000	1.000

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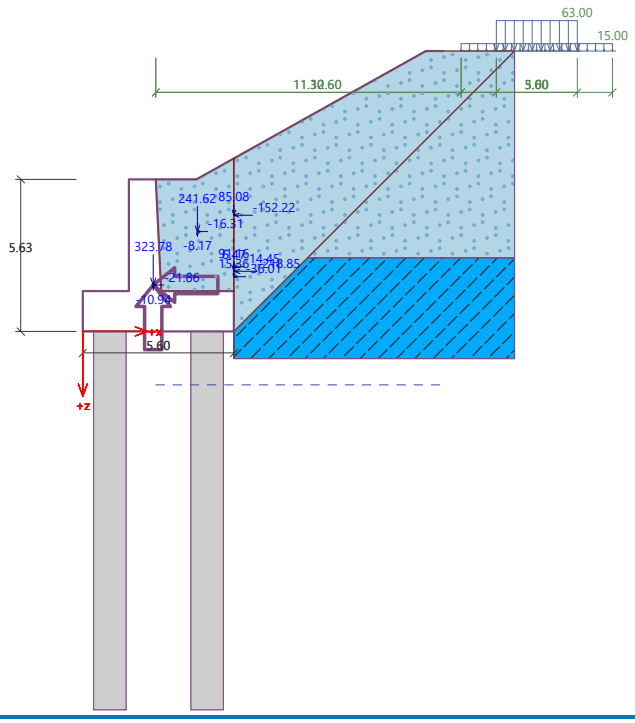
Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - earth wedge	0.00	-3.69	241.62	4.24	1.000	1.000	1.000
Earthquake - soil wedge	16.31	-3.69	-8.17	4.24	1.000	1.000	1.000
Active pressure	218.85	-2.22	91.16	5.60	1.000	1.000	1.000
Water pressure	0.00	-5.63	0.00	5.60	1.000	1.000	1.000
Earthq.- act.pressure	152.22	-4.30	85.08	5.60	1.000	1.000	1.000
Voz1	36.01	-2.03	15.36	5.60	0.700	0.700	0.700
Tucanik	14.45	-2.40	6.47	5.60	1.000	1.000	1.000

Verification of complete wall

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 175.09 kPa

Name : Verification	Stage - analysis : 2 - 1



Warning - allowable range of input data exceeded during earthquake analysis!
The analysis is carried out with the modified value of terrain inclination β. (β=29.20°, β_{modif}=26.00°)

Bearing capacity of foundation soil (Stage of construction 2)

Forces acting in the center of pile foundation

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	508.63	739.75	448.88

Normal forces acting in the center of pile foundation

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	517.65	744.35	459.69

Input parameters for bearing capacity analysis

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Pile spacing s = 3.60 m
Overall number of pile rows n = 2
Loading length l = 7.20 m

Verification of pile group

Verification No. 1

Dimensioning of piles - input data

Analysis carried out with an automatic selection of the most unfavorable LC.
Reinforcement designed for all piles in the group.

Verification of cross section in bending and compression:

Pile diameter: d=1.20m
Reinforcement - 18 pc bars 25.0 mm; cover 90.0 mm
Type of structure (reinforcement ratio) : pile
Reinforcement ratio $\rho = 0.781\ \% > 0.250\ \% = \rho_{min}$
Load : $N_{Ed} = 70.93$ kN (compression) ; $M_{Ed} = 1747.13$ kNm
Bearing capacity : $N_{Rd} = 71.91$ kN; $M_{Rd} = 1771.26$ kNm

Designed pile reinforcement is SATISFACTORY

Verification of cross section in shear:

Shear reinf. - 2 profile 12.0 mm; distance 150.0 mm
$A_{sw} = 1508.0\ mm^2$
Ultimate shear force: $V_{Rd} = 1416.18$ kN > 827.42 kN = V_{Ed}

Cross-section is SATISFACTORY.

Distribution of forces on construction

Depth [m]	Shear force Q [kN]	Bending moment M [kNm]	Normal force N [kN] (tension)	Normal force N [kN] (compression)
0.00	827.42	73.68	-171.61	-2508.07
1.40	509.70	998.32	-166.96	-2443.37
2.80	257.27	1527.78	-157.69	-2300.23
4.20	65.81	1747.13	-148.45	-2143.63
5.60	97.75	1717.42	-138.41	-1973.37
7.00	217.87	1488.94	-126.75	-1775.34
8.40	276.92	1135.86	-114.29	-1563.84
9.80	281.09	739.16	-101.87	-1352.86
11.20	234.82	372.33	-89.47	-1142.27
12.60	140.75	103.95	-77.11	-932.02
14.00	0.00	0.00	-70.93	-826.98

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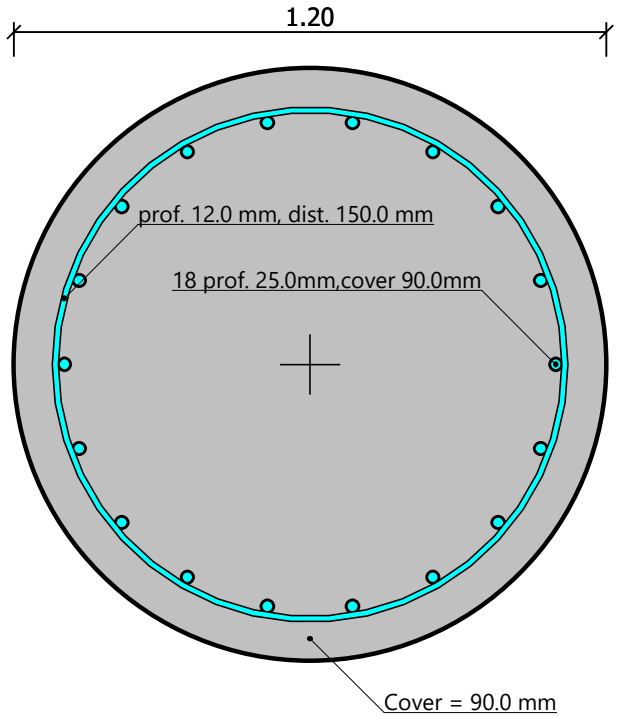
Reinforcement drawing



Pile verification

Vertical bear.cap. No.1 - Floating pile

Verification of pile bearing capacity according to NAVFAC DM 7.2 - partial results

Pile base bearing capacity:
The soil under the base is cohesionless
Coefficient of bearing capacity N_q = 10.00
Area of pile transverse cross-section A_p = 1.13E+00 m^2

Plie shaft resistance:

Depth [m]	Thickness [m]	c_{ud} [kPa]	α [–]	K [–]	δ [°]	σ_{or} [kPa]	R_{si} [kN]
0.00	-	-	-	-	-	-	-
1.97	1.97	-	-	1.17	19.50	20.00	61.58
1.97	-	-	-	-	-	-	-
4.87	2.90	-	-	1.17	19.50	54.93	249.02
4.87	-	-	-	-	-	-	-
14.00	9.13	-	-	1.28	22.50	115.97	2112.60

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out with automatic selection of the most unfavourable load cases.
Efficiency of pile group η_g = 1.00
Factor determining critical depth k_{dc} = 24.00

Verification of compressive pile:
Most unfavorable load case No. 3. (LC 3)
Pile skin bearing capacity R_s = 2423.20 kN
Pile base bearing capacity R_b = 1833.01 kN

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Pile bearing capacity R_c = 4256.22 kN
Ultimate vertical force V_d = 2508.07 kN

R_c = 4256.22 kN > 2508.07 kN = V_d

Pile bearing capacity is SATISFACTORY

Dimensioning No. 1 (Stage of construction 2)

Wall stem check - front reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-2.00	113.87	0.55	1.000	1.000	1.000
Earthq.- constr.	7.69	-2.00	-3.85	0.55	1.000	1.000	1.000
Pressure at rest	48.95	-1.28	9.79	1.14	1.000	1.000	1.000
Water pressure	0.00	-4.13	0.00	1.00	1.000	1.000	1.000
Earthquake - pressure at rest	22.24	-2.06	0.00	1.00	1.000	1.000	1.000
Voz1	21.54	-2.01	4.31	1.11	0.700	0.700	0.700
Tucanik	9.64	-2.02	1.93	1.11	1.000	1.000	1.000

Wall stem check - front reinf. - V_{Ed}

Wall check at the construction joint 4.13 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1550.0 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.21 m

Ultimate shear force V_{Rd} = 338.65 kN > 103.59 kN = V_{Ed}

Cross-section is SATISFACTORY.

Wall stem check - front reinf. - M_{Ed}

Wall check at the construction joint 0.08 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1550.0 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.00 m

Reinforcement ratio ρ = 0.22 % > 0.14 % = ρ_{min}
Position of neutral axis x = 0.07 m < 0.58 m = x_{max}
Ultimate moment M_{Rd} = 830.63 kNm > 0.00 kNm = M_{Ed}

Cross-section is SATISFACTORY.

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Wall stem check - back reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-2.00	113.87	0.55	1.000	1.000	1.000
Earthq.- constr.	7.69	-2.00	-3.85	0.55	1.000	1.000	1.000
Pressure at rest	48.95	-1.28	9.79	1.14	1.000	1.000	1.000
Water pressure	0.00	-4.13	0.00	1.00	1.000	1.000	1.000
Earthquake - pressure at rest	22.24	-2.06	0.00	1.00	1.000	1.000	1.000
Voz1	21.54	-2.01	4.31	1.11	0.700	0.700	0.700
Tucanik	9.64	-2.02	1.93	1.11	1.000	1.000	1.000

Wall stem check - back reinf.

Wall check at the construction joint 4.13 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1550.0 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.21 m

Reinforcement ratio	ρ	=	0.18 %	>	0.14 %	=	ρ_{min}
Position of neutral axis	x	=	0.07 m	<	0.71 m	=	x_{max}
Ultimate shear force	V_{Rd}	=	338.65 kN	>	103.59 kN	=	V_{Ed}
Ultimate moment	M_{Rd}	=	1015.02 kNm	>	171.61 kNm	=	M_{Ed}

Cross-section is SATISFACTORY.

Wall jump check

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-1.72	323.78	2.61	1.000
Earthq.- constr.	21.86	-1.72	-10.94	2.61	1.000
Weight - earth wedge	0.00	-3.69	241.62	4.24	1.000
Earthquake - soil wedge	16.31	-3.69	-8.17	4.24	1.000
Active pressure	218.85	-2.22	91.16	5.60	1.000
Water pressure	0.00	-5.63	0.00	5.60	1.000
Earthq.- act.pressure	152.22	-4.30	85.08	5.60	1.000
Voz1	36.01	-2.03	15.36	5.60	0.700
Tucanik	14.45	-2.40	6.47	5.60	1.000

Wall jump check

Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1946.9 mm^2

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Cross-section width = 1.00 m
Cross-section height = 1.50 m

Reinforcement ratio	ρ	=	0.15	%	>	0.14	%	=	ρ_{min}
Position of neutral axis	x	=	0.08	m	<	0.89	m	=	x_{max}
Ultimate shear force	V_{Rd}	=	405.28	kN	>	275.99	kN	=	V_{Ed}
Ultimate moment	M_{Rd}	=	1282.63	kNm	>	248.81	kNm	=	M_{Ed}

Cross-section is SATISFACTORY.

Wall heel check

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-0.75	100.88	4.25	1.000
Weight - earth wedge	0.00	-3.69	241.62	4.24	1.000
Active pressure	218.85	-2.22	91.16	5.60	1.000
Voz1	36.01	-2.03	15.36	5.60	0.700
Tucanik	14.45	-2.40	6.47	5.60	1.000
Contact stress	0.00	0.00	-219.79	4.00	1.000

Wall heel check

Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1946.9 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.50 m

Reinforcement ratio	ρ	=	0.15	%	>	0.14	%	=	ρ_{min}
Position of neutral axis	x	=	0.08	m	<	0.89	m	=	x_{max}
Ultimate shear force	V_{Rd}	=	405.28	kN	>	231.09	kN	=	V_{Ed}
Ultimate moment	M_{Rd}	=	1282.63	kNm	>	510.45	kNm	=	M_{Ed}

Cross-section is SATISFACTORY.

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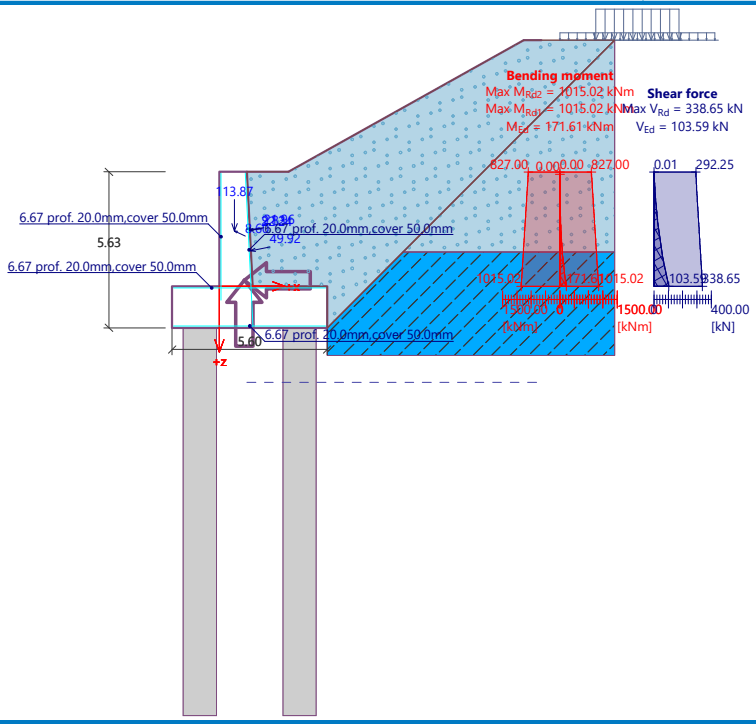
Name : Dimensioning	Stage - analysis : 2 - 1



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Потпорни зидови уз галерију на km 78+377 пруге

Кампада 4

Retaining Walls adjacent to the gallery at km 78+377 of the railway line

Section 4

Cantilever wall analysis

Input data

Project

Task : Пројекат потпорних конструкција
Part : Деоница: Нови Сад - Суботица - Државна граница (Келебија)
Description : Потпорни зид на км 78+377 пруге - Кампада 4
Date : 14.4.2021.

Settings

Standard - EN 1997 - PP2 - SRB

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : user-defined
Article 3.1.6 : $\alpha_{cc} = 0.85$

Wall analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Caquot-Kerisel
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Consider always vertical
Base key : The base key is considered as inclined footing bottom
Allowable eccentricity : 0.170
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

Partial factors on actions (A)					
Permanent design situation					
		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.35	[–]	1.00	[–]
Variable actions :	γ_Q =	1.50	[–]	0.00	[–]
Water load :	γ_w =	1.35	[–]		

Partial factors for resistances (R)			
Permanent design situation			
Partial factor on overturning :	γ_{Rv} =	1.40	[–]
Partial factor on sliding resistance :	γ_{Rh} =	1.10	[–]
Partial factor on bearing capacity :	γ_{Re} =	1.40	[–]

Partial factors for variable actions			
Permanent design situation			
Factor for combination value :	ψ_0 =	0.70	[–]
Factor for frequent value :	ψ_1 =	0.50	[–]
Factor for quasi-permanent value :	ψ_2 =	0.30	[–]

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Partial factors on actions (A)					
Seismic design situation					
		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.00	[–]	1.00	[–]
Variable actions :	γ_Q =	1.00	[–]	0.00	[–]
Water load :	γ_w =	1.00	[–]		

Partial factors for resistances (R)			
Seismic design situation			
Partial factor on overturning :	γ_{Rv} =	1.40	[–]
Partial factor on sliding resistance :	γ_{Rh} =	1.25	[–]
Partial factor on bearing capacity :	γ_{Re} =	1.40	[–]

Material of structure

Unit weight γ = 25.00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete: C 25/30
Cylinder compressive strength f_{ck} = 25.00 MPa
Tensile strength f_{ctm} = 2.60 MPa

Longitudinal steel: B500B
Yield strength f_{yk} = 500.00 MPa

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0.00	0.00
2	0.26	5.23
3	2.90	5.23
4	2.90	6.73
5	-2.70	6.73
6	-2.70	5.23
7	-1.00	5.23
8	-1.00	0.00

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 14.32 m^2.

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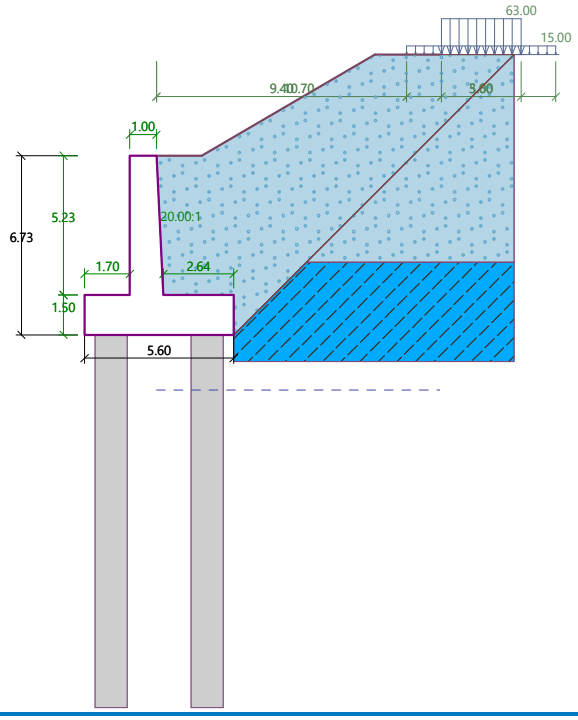
Name : Geometry	Stage - analysis : 1 - 0



Basic soil parameters

No.	Name	Pattern	ϕ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
1	Zasip		30.00	0.00	20.00	10.00	10.00
2	siSa		26.00	12.00	20.30	10.30	8.00
3	SaP		30.00	5.00	20.10	10.10	10.00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	ϕ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
1	Zasip		cohesive	-	0.20	-	-
2	siSa		cohesive	-	0.30	-	-
3	SaP		cohesive	-	0.28	-	-

Soil parameters

Zasip

Unit weight :	γ =	20.00 kN/m^3
Stress-state :		effective
Angle of internal friction :	ϕ_{ef} =	30.00 °
Cohesion of soil :	c_{ef} =	0.00 kPa
Angle of friction struc.-soil :	δ =	10.00 °
Soil :		cohesive
Poisson's ratio :	ν =	0.20

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Saturated unit weight : γ_{sat} = 20.00 kN/m^3

siSa

Unit weight : γ = 20.30 kN/m^3
Stress-state : effective
Angle of internal friction : ϕ_{ef} = 26.00 °
Cohesion of soil : c_{ef} = 12.00 kPa
Angle of friction struc.-soil : δ = 8.00 °
Soil : cohesive
Poisson's ratio : ν = 0.30
Saturated unit weight : γ_{sat} = 20.30 kN/m^3

SaP

Unit weight : γ = 20.10 kN/m^3
Stress-state : effective
Angle of internal friction : ϕ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 5.00 kPa
Angle of friction struc.-soil : δ = 10.00 °
Soil : cohesive
Poisson's ratio : ν = 0.28
Saturated unit weight : γ_{sat} = 20.10 kN/m^3

Backfill

Assigned soil : Zasip
Slope = 45.00 °

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	4.00	0.00 .. 4.00	Zasip	
2	7.60	4.00 .. 11.60	siSa	
3	14.30	11.60 .. 25.90	SaP	
4	-	25.90 .. ∞	SaP	

Foundation

Type of foundation : pile foundation
Unit weight γ = 25.00 kN/m^3

Geometry

Length l = 14.00 m
Offset d = 1.20 m
Diameter x = 0.40 m
Spacing b = 2.40 m

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Terrain profile

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	1.70	0.00
3	8.20	-3.80
4	9.20	-3.80

Origin [0,0] is located in upper right edge of construction.
Positive coordinate +z has downward direction.

Water influence

GWT behind the structure lies at a depth of 8.80 m
Uplift in foot. bottom due to different pressures is not considered.

Input surface surcharges

No.	Surcharge		Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
	new	change						
1	Yes		variable	63.00		10.70	3.00	on terrain
2	Yes		permanent	15.00		9.40	5.60	on terrain

No.	Name
1	Voz1
2	Tucanik

Resistance on front face of the structure

Resistance on front face of the structure is not considered.

Settings of the stage of construction

Design situation : permanent
The wall is free to move. Active earth pressure is therefore assumed.

Verification No. 1 (Stage of construction 1)

Active pressure behind the structure - partial results

Layer No.	Thickness [m]	α [°]	ϕ_d [°]	c_d [kPa]	γ [kN/m³]	δ_d [°]	K_a	Comment
1	0.70	0.00	30.00	0.00	20.00	30.00	0.871	
2	0.90	0.00	30.00	0.00	20.00	30.00	0.871	
3	0.10	0.00	30.00	0.00	20.00	30.00	0.297	
4	3.00	0.00	30.00	0.00	20.00	30.00	0.297	
5	1.23	0.00	30.00	0.00	20.00	30.00	0.297	
6	1.50	0.00	30.00	0.00	20.00	10.00	0.308	

Active pressure distribution behind the structure (without surcharge)

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.70	0.00	0.00	0.00	0.00	0.00
	0.00	14.05	0.00	12.24	10.60	6.12

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Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
2	0.00	14.05	0.00	12.24	10.60	6.12
	0.90	32.09	0.00	27.95	24.20	13.97
3	0.90	32.09	0.00	27.95	24.20	13.97
	1.00	34.05	0.00	28.53	24.71	14.26
4	1.00	34.05	0.00	28.53	24.71	14.26
	4.00	94.05	0.00	46.36	40.15	23.18
5	4.00	94.05	0.00	46.36	40.15	23.18
	5.23	118.65	0.00	53.67	46.48	26.83
6	5.23	118.65	0.00	55.71	54.86	9.67
	6.73	148.65	0.00	64.96	63.98	11.28

Water pressure distribution

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.70	0.00	0.00
2	0.00	0.00	0.00
3	0.90	0.00	0.00
4	1.00	0.00	0.00
5	4.00	0.00	0.00
6	5.23	0.00	0.00
7	6.73	0.00	0.00

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-2.10	357.90	2.58	1.000	1.000	1.350
Weight - earth wedge	0.00	-4.24	298.26	4.24	1.000	1.000	1.350
Active pressure	261.50	-2.73	115.23	5.60	1.350	1.350	1.350
Water pressure	0.00	-6.73	0.00	5.60	1.000	1.000	1.350
Voz1	48.51	-2.81	22.95	5.60	1.500	1.500	1.500
Tucanik	18.70	-3.14	8.99	5.60	1.350	1.350	1.350

Verification of complete wall

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 208.42 kPa

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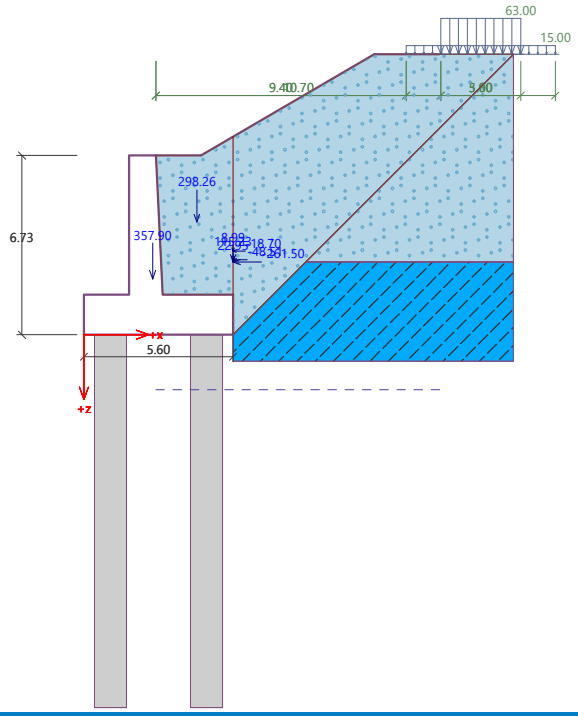
Name : Verification	Stage - analysis : 1 - 1



Bearing capacity of foundation soil (Stage of construction 1)

Forces acting in the center of pile foundation

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	206.78	1087.95	451.04
2	329.94	858.29	451.04

Normal forces acting in the center of pile foundation

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	145.17	803.34	328.71

Input parameters for bearing capacity analysis

Pile spacing s = 3.60 m
Overall number of pile rows n = 2
Loading length l = 7.20 m

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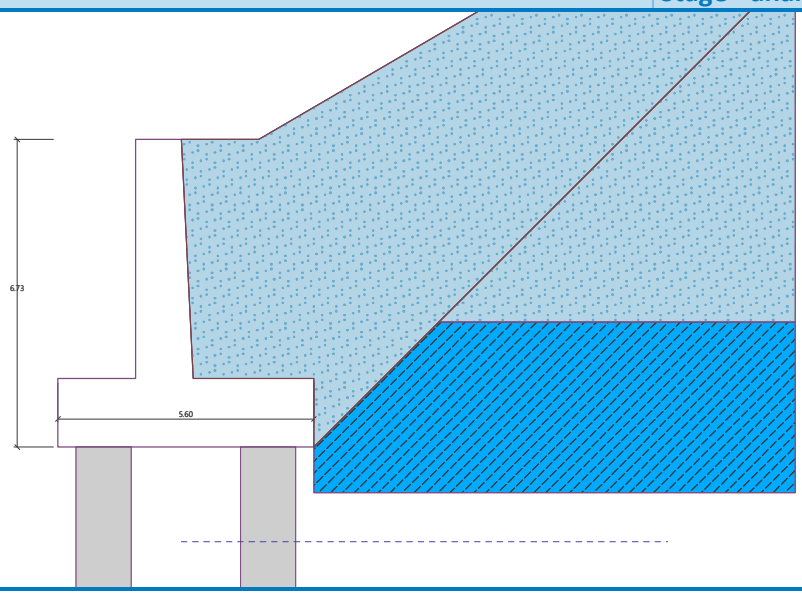
Name : Bearing cap.	Stage - analysis : 1 - -1



Verification of pile group

Verification No. 1

Dimensioning of piles - input data

Analysis carried out with an automatic selection of the most unfavorable LC.
Reinforcement designed for all piles in the group.

Verification of cross section in bending and compression:

Pile diameter: d=1.20m
Reinforcement - 22 pc bars 25.0 mm; cover 90.0 mm
Type of structure (reinforcement ratio) : pile
Reinforcement ratio $\rho = 0.955\ \% > 0.250\ \% = \rho_{min}$
Load : $N_{Ed} = 160.58$ kN (compression) ; $M_{Ed} = 1586.54$ kNm
Bearing capacity : $N_{Rd} = 218.09$ kN; $M_{Rd} = 2154.69$ kNm

Designed pile reinforcement is SATISFACTORY

Verification of cross section in shear:

Shear reinf. - 2 profile 12.0 mm; distance 200.0 mm
$A_{sw} = 1131.0\ mm^2$
Ultimate shear force: $V_{Rd} = 1062.13$ kN > 811.86 kN = V_{Ed}

Cross-section is SATISFACTORY.

Distribution of forces on construction

Depth [m]	Shear force Q [kN]	Bending moment M [kNm]	Normal force N [kN] (tension)	Normal force N [kN] (compression)
0.00	811.86	231.03	-481.90	-2969.98
1.40	514.43	815.06	-468.85	-2904.69
2.80	276.16	1350.01	-440.88	-2744.06
4.20	93.78	1586.54	-411.09	-2553.73
5.60	77.70	1581.98	-378.69	-2346.71
7.00	195.64	1383.44	-341.01	-2105.95
8.40	255.15	1061.44	-300.78	-1848.75
9.80	261.99	693.57	-260.63	-1592.16

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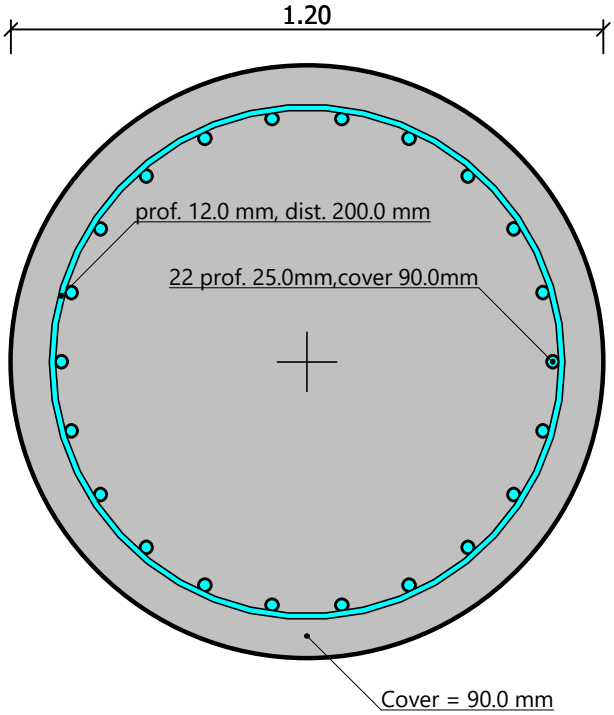
Depth [m]	Shear force Q [kN]	Bending moment M [kNm]	Normal force N [kN] (tension)	Normal force N [kN] (compression)
11.20	220.34	350.46	-220.57	-1336.17
12.60	132.65	98.08	-180.57	-1080.58
14.00	0.00	0.00	-160.58	-952.85

Reinforcement drawing



Pile verification

Vertical bear.cap. No.1 - Floating pile

Verification of pile bearing capacity according to NAVFAC DM 7.2 - partial results

Pile base bearing capacity:
The soil under the base is cohesionless
Coefficient of bearing capacity N_q = 10.00
Area of pile transverse cross-section A_p = 1.13E+00 m^2

Plie shaft resistance:

Depth [m]	Thickness [m]	c_{ud} [kPa]	α [–]	K [–]	δ [°]	σ_{or} [kPa]	R_{si} [kN]
0.00	-	-	-	-	-	-	-
2.07	2.07	-	-	1.17	19.50	21.01	61.81
2.07	-	-	-	-	-	-	-
4.87	2.80	-	-	1.17	19.50	56.44	224.60
4.87	-	-	-	-	-	-	-
14.00	9.13	-	-	1.28	22.50	116.97	1937.11

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out with automatic selection of the most unfavourable load cases.
Efficiency of pile group η_g = 0.90

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Factor determining critical depth k_{dc} = 24.00

Verification of compressive pile:
Most unfavorable load case No. 1. (LC 1)
Pile skin bearing capacity R_s = 2223.52 kN
Pile base bearing capacity R_b = 1676.66 kN

Pile bearing capacity R_c = 3510.16 kN
Ultimate vertical force V_d = 2969.98 kN

R_c = 3510.16 kN > 2969.98 kN = V_d

Pile bearing capacity is SATISFACTORY

Dimensioning No. 1 (Stage of construction 1)

Wall stem check - front reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-2.51	147.81	0.57	1.350	1.350	1.000
Pressure at rest	83.67	-1.60	16.73	1.18	1.350	1.350	1.350
Water pressure	0.00	-5.23	0.00	1.00	1.000	1.000	1.000
Voz1	31.40	-2.56	6.28	1.13	1.500	1.500	1.500
Tucanik	14.05	-2.57	2.81	1.13	1.350	1.350	1.350

Wall stem check - front reinf. - V_{Ed}

Wall check at the construction joint 5.23 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 18.0 mm, cover 50.0 mm
Inputted reinforcement area = 1697.3 mm^2
Required reinforcement area = 1625.7 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.26 m

Ultimate shear force V_{Rd} = 351.50 kN > 179.02 kN = V_{Ed}

Cross-section is SATISFACTORY.

Wall stem check - front reinf. - M_{Ed}

Wall check at the construction joint 0.10 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 18.0 mm, cover 50.0 mm
Inputted reinforcement area = 1697.3 mm^2
Required reinforcement area = 1625.7 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.01 m

Reinforcement ratio ρ = 0.18 % > 0.14 % = ρ_{min}
Position of neutral axis x = 0.06 m < 0.58 m = x_{max}
Ultimate moment M_{Rd} = 678.61 kNm > 0.01 kNm = M_{Ed}

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Cross-section is SATISFACTORY.

Wall stem check - back reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-2.51	147.81	0.57	1.350	1.350	1.000
Pressure at rest	83.67	-1.60	16.73	1.18	1.350	1.350	1.350
Water pressure	0.00	-5.23	0.00	1.00	1.000	1.000	1.000
Voz1	31.40	-2.56	6.28	1.13	1.500	1.500	1.500
Tucanik	14.05	-2.57	2.81	1.13	1.350	1.350	1.350

Wall stem check - back reinf.

Wall check at the construction joint 5.23 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 18.0 mm, cover 50.0 mm
Inputted reinforcement area = 1697.3 mm^2
Required reinforcement area = 1625.7 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.26 m

Reinforcement ratio	ρ	=	0.14 %	>	0.14 %	=	ρ_{min}
Position of neutral axis	x	=	0.06 m	<	0.74 m	=	x_{max}
Ultimate shear force	V_{Rd}	=	351.50 kN	>	179.02 kN	=	V_{Ed}
Ultimate moment	M_{Rd}	=	867.76 kNm	>	343.38 kNm	=	M_{Ed}

Cross-section is SATISFACTORY.

Wall jump check

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-2.10	357.90	2.58	1.350
Weight - earth wedge	0.00	-4.24	298.26	4.24	1.350
Active pressure	261.50	-2.73	115.23	5.60	1.350
Water pressure	0.00	-6.73	0.00	5.60	1.350
Voz1	48.51	-2.81	22.95	5.60	1.500
Tucanik	18.70	-3.14	8.99	5.60	1.350

Wall jump check

Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1946.9 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.50 m

Reinforcement ratio	ρ	=	0.15 %	>	0.14 %	=	ρ_{min}
Position of neutral axis	x	=	0.08 m	<	0.89 m	=	x_{max}

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Ultimate shear force V_{Rd} = 405.28 kN > 313.44 kN = V_{Ed}
Ultimate moment M_{Rd} = 1282.63 kNm > 272.22 kNm = M_{Ed}

Cross-section is SATISFACTORY.

Wall heel check

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-0.75	99.00	4.28	1.350
Weight - earth wedge	0.00	-4.24	298.26	4.24	1.350
Active pressure	261.50	-2.73	115.23	5.60	1.350
Voz1	48.51	-2.81	22.95	5.60	1.500
Tucanik	18.70	-3.14	8.99	5.60	1.350
Contact stress	0.00	0.00	-457.34	4.23	1.000

Wall heel check

Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1946.9 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.50 m

Reinforcement ratio ρ = 0.15 % > 0.14 % = ρ_{min}
Position of neutral axis x = 0.08 m < 0.89 m = x_{max}
Ultimate shear force V_{Rd} = 405.28 kN > 281.09 kN = V_{Ed}
Ultimate moment M_{Rd} = 1282.63 kNm > 644.07 kNm = M_{Ed}

Cross-section is SATISFACTORY.

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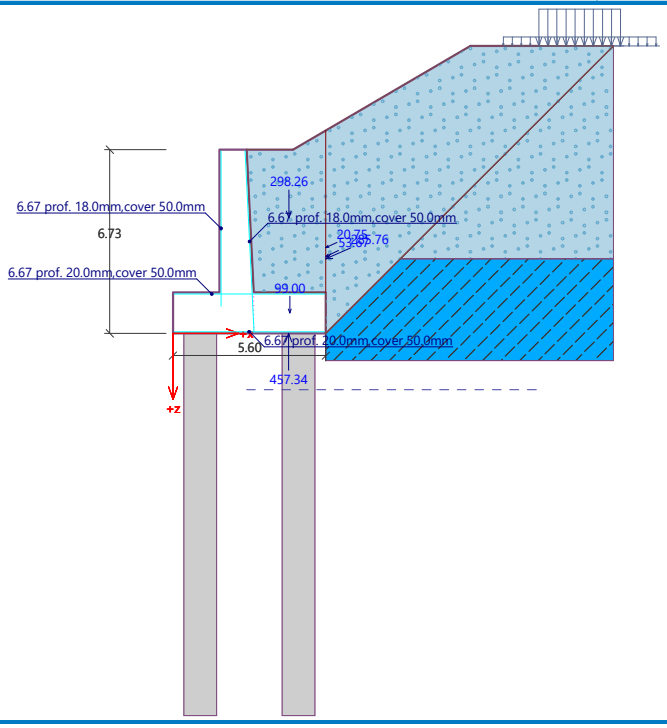
Name : Dimensioning	Stage - analysis : 1 - 1



Input data (Stage of construction 2)

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	4.00	0.00 .. 4.00	Zasip	
2	7.60	4.00 .. 11.60	siSa	
3	14.30	11.60 .. 25.90	SaP	
4	-	25.90 .. ∞	SaP	

Foundation

Type of foundation : pile foundation
Unit weight γ = 25.00 kN/m^3

Geometry

Length l = 14.00 m
Offset d = 1.20 m
Diameter x = 0.40 m
Spacing b = 2.40 m

Terrain profile

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	1.70	0.00
3	8.20	-3.80

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No.	Coordinates x [m]	Depth z [m]
4	9.20	-3.80

Origin [0,0] is located in upper right edge of construction.
Positive coordinate +z has downward direction.

Water influence

GWT behind the structure lies at a depth of 8.80 m
Uplift in foot. bottom due to different pressures is not considered.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	No	No	variable	63.00		10.70	3.00	on terrain
2	No	No	permanent	15.00		9.40	5.60	on terrain

No.	Name
1	Voz1
2	Tucanik

Resistance on front face of the structure

Resistance on front face of the structure is not considered.

Earthquake

Factor of horizontal acceleration K_h = 0.0675
Factor of vertical acceleration K_v = 0.0338

Water below the GWT is restricted.

Settings of the stage of construction

Design situation : seismic
The wall is free to move. Active earth pressure is therefore assumed.

Verification No. 1 (Stage of construction 2)

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-2.10	357.90	2.58	1.000	1.000	1.000
Earthq.- constr.	24.16	-2.10	-12.10	2.58	1.000	1.000	1.000
Weight - earth wedge	0.00	-4.24	298.26	4.24	1.000	1.000	1.000
Earthquake - soil wedge	20.13	-4.24	-10.08	4.24	1.000	1.000	1.000
Active pressure	261.50	-2.73	115.23	5.60	1.000	1.000	1.000
Water pressure	0.00	-6.73	0.00	5.60	1.000	1.000	1.000
Earthq.- act.pressure	205.11	-4.98	115.61	5.60	1.000	1.000	1.000
Voz1	48.51	-2.81	22.95	5.60	0.700	0.700	0.700
Tucanik	18.70	-3.14	8.99	5.60	1.000	1.000	1.000

Verification of complete wall

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 260.10 kPa

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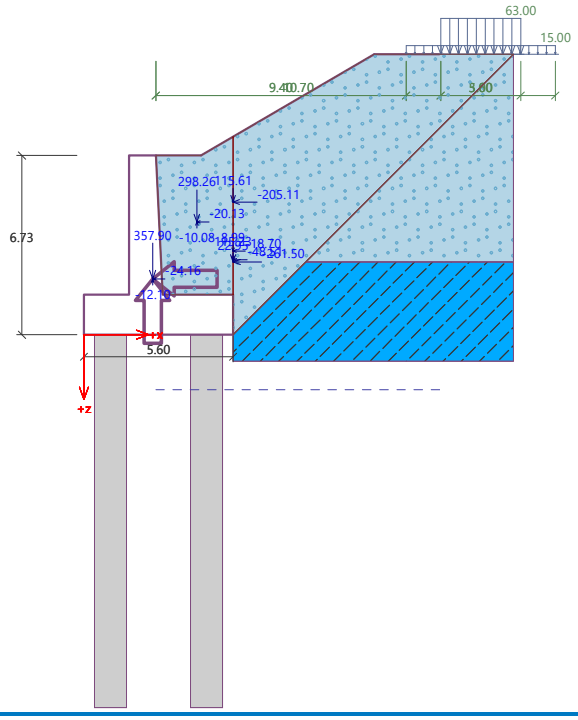
Name : Verification	Stage - analysis : 2 - 1



Warning - allowable range of input data exceeded during earthquake analysis!
The analysis is carried out with the modified value of terrain inclination β. (β=27.00°, β_{modif}=26.00°)

Bearing capacity of foundation soil (Stage of construction 2)

Forces acting in the center of pile foundation

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	969.41	889.88	563.56

Normal forces acting in the center of pile foundation

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	991.02	896.77	578.11

Input parameters for bearing capacity analysis

Pile spacing s = 3.60 m
Overall number of pile rows n = 2
Loading length l = 7.20 m

Verification of pile group

Verification No. 1

Dimensioning of piles - input data

Analysis carried out with an automatic selection of the most unfavorable LC.
Reinforcement designed for all piles in the group.

Verification of cross section in bending and compression:

Pile diameter: d=1.20m
Reinforcement - 23 pc bars 28.0 mm; cover 90.0 mm
Type of structure (reinforcement ratio) : pile
Reinforcement ratio ρ = 1.252 % > 0.250 % = ρ_{min}

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Load : N_{Ed} = 29.03 kN (compression) ; M_{Ed} = 2545.08 kNm
Bearing capacity : N_{Rd} = 30.05 kN; M_{Rd} = 2634.44 kNm

Designed pile reinforcement is SATISFACTORY

Verification of cross section in shear:

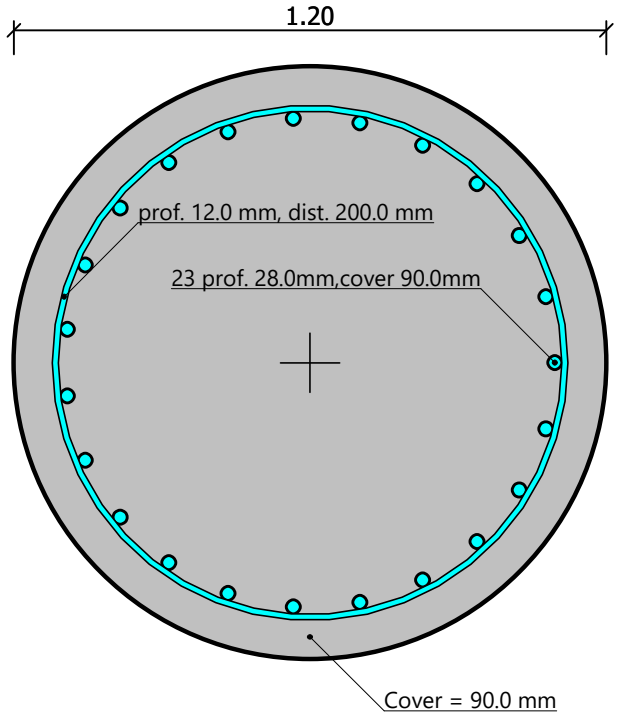
Shear reinf. - 2 profile 12.0 mm; distance 200.0 mm
A_{sw} = 1131.0 mm^2
Ultimate shear force: V_{Rd} = 1062.13 kN > 1040.58 kN = V_{Ed}

Cross-section is SATISFACTORY.

Distribution of forces on construction

Depth [m]	Shear force Q [kN]	Bending moment M [kNm]	Normal force N [kN] (tension)	Normal force N [kN] (compression)
0.00	1040.58	552.67	-63.02	-3165.35
1.40	618.83	1703.47	-61.45	-3106.60
2.80	286.77	2327.28	-58.31	-2949.00
4.20	37.53	2545.08	-55.19	-2745.98
5.60	172.52	2440.74	-51.80	-2518.98
7.00	323.38	2083.58	-47.86	-2255.01
8.40	393.36	1572.98	-43.66	-1973.00
9.80	391.09	1015.85	-39.47	-1691.59
11.20	322.72	508.73	-35.28	-1410.73
12.60	191.84	141.37	-31.11	-1130.35
14.00	0.00	0.00	-29.03	-990.28

Reinforcement drawing



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Dimensioning No. 1 (Stage of construction 2)

Wall stem check - front reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-2.51	147.81	0.57	1.000	1.000	1.000
Earthq.- constr.	9.98	-2.51	-5.00	0.57	1.000	1.000	1.000
Pressure at rest	83.67	-1.60	16.73	1.18	1.000	1.000	1.000
Water pressure	0.00	-5.23	0.00	1.00	1.000	1.000	1.000
Earthquake - pressure at rest	35.66	-2.61	0.00	1.00	1.000	1.000	1.000
Voz1	31.40	-2.56	6.28	1.13	0.700	0.700	0.700
Tucanik	14.05	-2.57	2.81	1.13	1.000	1.000	1.000

Wall stem check - front reinf. - V_{Ed}

Wall check at the construction joint 5.23 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 18.0 mm, cover 50.0 mm
Inputted reinforcement area = 1697.3 mm^2
Required reinforcement area = 1625.7 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.26 m

Ultimate shear force V_{Rd} = 351.50 kN > 165.34 kN = V_{Ed}
Cross-section is SATISFACTORY.

Wall stem check - front reinf. - M_{Ed}

Wall check at the construction joint 0.10 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 18.0 mm, cover 50.0 mm
Inputted reinforcement area = 1697.3 mm^2
Required reinforcement area = 1625.7 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.01 m

Reinforcement ratio ρ = 0.18 % > 0.14 % = ρ_{min}
Position of neutral axis x = 0.05 m < 0.58 m = x_{max}
Ultimate moment M_{Rd} = 680.19 kNm > 0.00 kNm = M_{Ed}

Cross-section is SATISFACTORY.

Wall stem check - back reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-2.51	147.81	0.57	1.000	1.000	1.000
Earthq.- constr.	9.98	-2.51	-5.00	0.57	1.000	1.000	1.000
Pressure at rest	83.67	-1.60	16.73	1.18	1.000	1.000	1.000
Water pressure	0.00	-5.23	0.00	1.00	1.000	1.000	1.000

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Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Earthquake - pressure at rest	35.66	-2.61	0.00	1.00	1.000	1.000	1.000
Voz1	31.40	-2.56	6.28	1.13	0.700	0.700	0.700
Tucanik	14.05	-2.57	2.81	1.13	1.000	1.000	1.000

Wall stem check - back reinf.

Wall check at the construction joint 5.23 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 18.0 mm, cover 30.0 mm
Inputted reinforcement area = 1697.3 mm^2
Required reinforcement area = 1652.7 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.26 m

Reinforcement ratio	ρ	=	0.14 %	>	0.14 %	=	ρ_{min}
Position of neutral axis	x	=	0.06 m	<	0.75 m	=	x_{max}
Ultimate shear force	V_{Rd}	=	356.07 kN	>	165.34 kN	=	V_{Ed}
Ultimate moment	M_{Rd}	=	882.52 kNm	>	340.64 kNm	=	M_{Ed}

Cross-section is SATISFACTORY.

Wall jump check

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-2.10	357.90	2.58	1.000
Earthq.- constr.	24.16	-2.10	-12.10	2.58	1.000
Weight - earth wedge	0.00	-4.24	298.26	4.24	1.000
Earthquake - soil wedge	20.13	-4.24	-10.08	4.24	1.000
Active pressure	261.50	-2.73	115.23	5.60	1.000
Water pressure	0.00	-6.73	0.00	5.60	1.000
Earthq.- act.pressure	205.11	-4.98	115.61	5.60	1.000
Voz1	48.51	-2.81	22.95	5.60	0.700
Tucanik	18.70	-3.14	8.99	5.60	1.000

Wall jump check

Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 30.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1973.9 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.50 m

Reinforcement ratio	ρ	=	0.14 %	>	0.14 %	=	ρ_{min}
Position of neutral axis	x	=	0.08 m	<	0.90 m	=	x_{max}
Ultimate moment	M_{Rd}	=	1300.86 kNm	>	391.61 kNm	=	M_{Ed}

Cross-section must be reinforced by shear reinforcement with minimal area of 299.8 mm^2/m.
Cross-section is SATISFACTORY.

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Wall heel check

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-0.75	99.00	4.28	1.000
Weight - earth wedge	0.00	-4.24	298.26	4.24	1.000
Active pressure	261.50	-2.73	115.23	5.60	1.000
Voz1	48.51	-2.81	22.95	5.60	0.700
Tucanik	18.70	-3.14	8.99	5.60	1.000
Contact stress	0.00	0.00	-159.17	3.68	1.000

Wall heel check

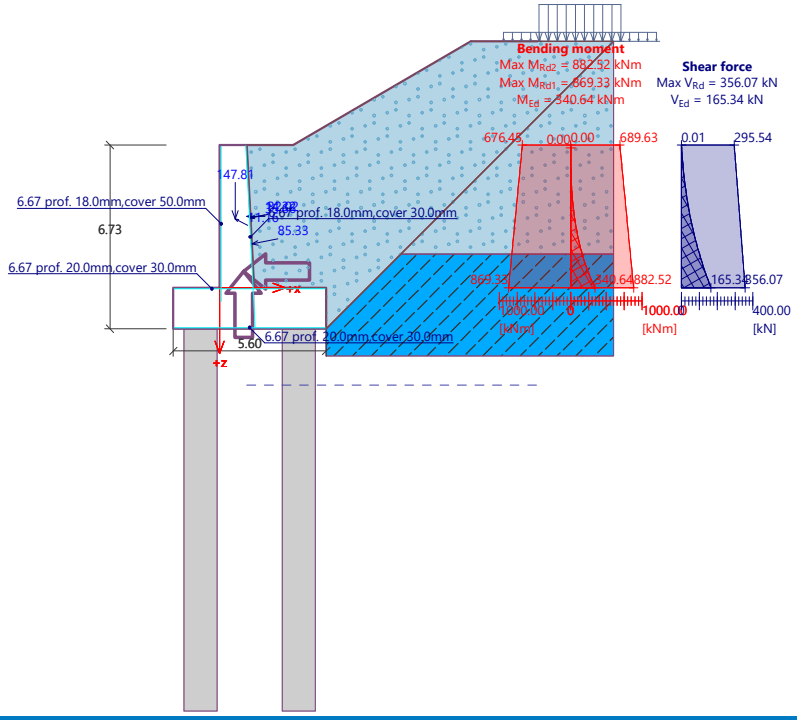
Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 30.0 mm

Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1973.9 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.50 m

Reinforcement ratio	ρ	=	0.14	%	>	0.14	%	= ρ_{min}
Position of neutral axis	x	=	0.08	m	<	0.90	m	= x_{max}
Ultimate shear force	V_{Rd}	=	409.76	kN	>	378.38	kN	= V_{Ed}
Ultimate moment	M_{Rd}	=	1300.86	kNm	>	768.11	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

Name : Dimensioning | **Stage - analysis : 2 - 1**



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Потпорни зидови уз галерију на km 78+377 пруге

Кампада 5

Retaining Walls adjacent to the gallery at km 78+377 of the railway line

Section 5

Cantilever wall analysis

Input data

Project

Task : Пројекат потпорних конструкција
Part : Деоница: Нови Сад - Суботица - Државна граница (Келебија)
Description : Потпорни зид на км 78+377 пруге - Кампада 5
Date : 14.4.2021.

Settings

Standard - EN 1997 - PP2 - SRB

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : user-defined
Article 3.1.6 : $\alpha_{cc} = 0.85$

Wall analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Caquot-Kerisel
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Consider always vertical
Base key : The base key is considered as inclined footing bottom
Allowable eccentricity : 0.170
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

Partial factors on actions (A)					
Permanent design situation					
		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.35	[–]	1.00	[–]
Variable actions :	γ_Q =	1.50	[–]	0.00	[–]
Water load :	γ_w =	1.35	[–]		

Partial factors for resistances (R)			
Permanent design situation			
Partial factor on overturning :	γ_{Rv} =	1.40	[–]
Partial factor on sliding resistance :	γ_{Rh} =	1.10	[–]
Partial factor on bearing capacity :	γ_{Re} =	1.40	[–]

Partial factors for variable actions			
Permanent design situation			
Factor for combination value :	ψ_0 =	0.70	[–]
Factor for frequent value :	ψ_1 =	0.50	[–]
Factor for quasi-permanent value :	ψ_2 =	0.30	[–]

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Partial factors on actions (A)					
Seismic design situation					
		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.00	[–]	1.00	[–]
Variable actions :	γ_Q =	1.00	[–]	0.00	[–]
Water load :	γ_w =	1.00	[–]		

Partial factors for resistances (R)			
Seismic design situation			
Partial factor on overturning :	γ_{Rv} =	1.40	[–]
Partial factor on sliding resistance :	γ_{Rh} =	1.25	[–]
Partial factor on bearing capacity :	γ_{Re} =	1.40	[–]

Material of structure

Unit weight γ = 25.00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete: C 25/30
Cylinder compressive strength f_{ck} = 25.00 MPa
Tensile strength f_{ctm} = 2.60 MPa

Longitudinal steel: B500B
Yield strength f_{yk} = 500.00 MPa

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0.00	0.00
2	0.26	5.23
3	2.90	5.23
4	2.90	6.73
5	-2.70	6.73
6	-2.70	5.23
7	-1.00	5.23
8	-1.00	0.00

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 14.32 m^2.

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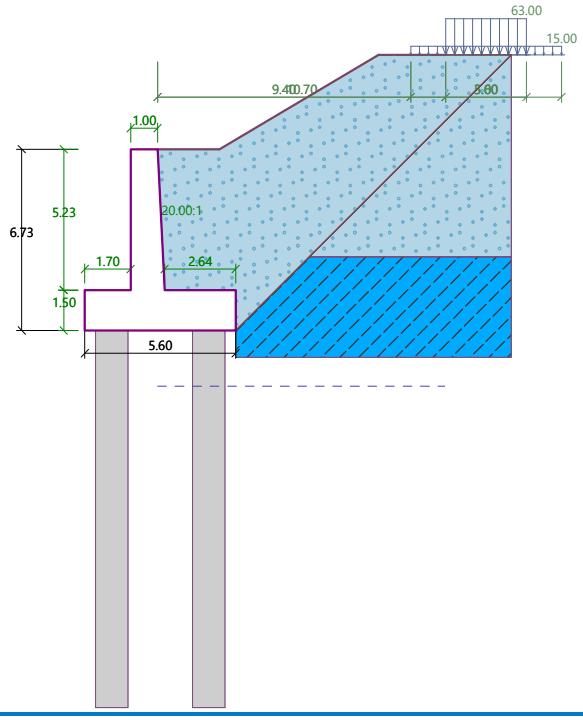
Name : Geometry	Stage - analysis : 1 - 0



Basic soil parameters

No.	Name	Pattern	ϕ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]	γ_{su} [kN/m³]	δ [°]
1	Zasip		30.00	0.00	20.00	10.00	10.00
2	siSa		26.00	12.00	20.30	10.30	8.00
3	SaP		30.00	5.00	20.10	10.10	10.00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	ϕ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
1	Zasip		cohesive	-	0.20	-	-
2	siSa		cohesive	-	0.30	-	-
3	SaP		cohesive	-	0.28	-	-

Soil parameters

Zasip

Unit weight :	γ =	20.00 kN/m³
Stress-state :		effective
Angle of internal friction :	ϕ_{ef} =	30.00 °
Cohesion of soil :	c_{ef} =	0.00 kPa
Angle of friction struc.-soil :	δ =	10.00 °
Soil :		cohesive
Poisson's ratio :	ν =	0.20

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Saturated unit weight : γ_{sat} = 20.00 kN/m^3

siSa

Unit weight : γ = 20.30 kN/m^3
Stress-state : effective
Angle of internal friction : ϕ_{ef} = 26.00 °
Cohesion of soil : c_{ef} = 12.00 kPa
Angle of friction struc.-soil : δ = 8.00 °
Soil : cohesive
Poisson's ratio : ν = 0.30
Saturated unit weight : γ_{sat} = 20.30 kN/m^3

SaP

Unit weight : γ = 20.10 kN/m^3
Stress-state : effective
Angle of internal friction : ϕ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 5.00 kPa
Angle of friction struc.-soil : δ = 10.00 °
Soil : cohesive
Poisson's ratio : ν = 0.28
Saturated unit weight : γ_{sat} = 20.10 kN/m^3

Backfill

Assigned soil : Zasip
Slope = 45.00 °

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	4.00	0.00 .. 4.00	Zasip	
2	7.60	4.00 .. 11.60	siSa	
3	14.30	11.60 .. 25.90	SaP	
4	-	25.90 .. ∞	SaP	

Foundation

Type of foundation : pile foundation
Unit weight γ = 25.00 kN/m^3

Geometry

Length l = 14.00 m
Offset d = 1.20 m
Diameter x = 0.40 m
Spacing b = 2.40 m

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Terrain profile

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	2.30	0.00
3	8.20	-3.50
4	9.20	-3.50

Origin [0,0] is located in upper right edge of construction.
Positive coordinate +z has downward direction.

Water influence

GWT behind the structure lies at a depth of 8.80 m
Uplift in foot. bottom due to different pressures is not considered.

Input surface surcharges

No.	Surcharge		Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
	new	change						
1	Yes		variable	63.00		10.70	3.00	on terrain
2	Yes		permanent	15.00		9.40	5.60	on terrain

No.	Name
1	Voz1
2	Tucanik

Resistance on front face of the structure

Resistance on front face of the structure is not considered.

Settings of the stage of construction

Design situation : permanent
The wall is free to move. Active earth pressure is therefore assumed.

Verification No. 1 (Stage of construction 1)

Active pressure behind the structure - partial results

Layer No.	Thickness [m]	α [°]	ϕ_d [°]	c_d [kPa]	γ [kN/m³]	δ_d [°]	K_a	Comment
1	0.36	0.00	30.00	0.00	20.00	30.00	0.884	
2	1.00	0.00	30.00	0.00	20.00	30.00	0.884	
3	0.24	0.00	30.00	0.00	20.00	30.00	0.884	
4	2.76	0.00	30.00	0.00	20.00	30.00	0.297	
5	1.23	0.00	30.00	0.00	20.00	30.00	0.297	
6	1.50	0.00	30.00	0.00	20.00	10.00	0.308	

Active pressure distribution behind the structure (without surcharge)

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.36	0.00	0.00	0.00	0.00	0.00
	0.00	7.14	0.00	6.31	5.46	3.15

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Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
2	0.00	7.14	0.00	6.31	5.46	3.15
	1.00	27.14	0.00	23.98	20.77	11.99
3	1.00	27.14	0.00	23.98	20.77	11.99
	1.24	31.85	0.00	28.15	24.37	14.07
4	1.24	31.85	0.00	28.15	24.37	14.07
	4.00	87.14	0.00	44.58	38.60	22.29
5	4.00	87.14	0.00	44.58	38.60	22.29
	5.23	111.74	0.00	51.89	44.93	25.94
6	5.23	111.74	0.00	53.86	53.04	9.35
	6.73	141.74	0.00	63.11	62.15	10.96

Water pressure distribution

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.36	0.00	0.00
2	0.00	0.00	0.00
3	1.00	0.00	0.00
4	1.24	0.00	0.00
5	4.00	0.00	0.00
6	5.23	0.00	0.00
7	6.73	0.00	0.00

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-2.10	357.90	2.58	1.000	1.000	1.350
Weight - earth wedge	0.00	-4.18	291.97	4.22	1.000	1.000	1.350
Active pressure	244.23	-2.61	106.36	5.60	1.350	1.350	1.350
Water pressure	0.00	-6.73	0.00	5.60	1.000	1.000	1.350
Voz1	48.79	-2.84	23.14	5.60	1.500	1.500	1.500
Tucanik	18.81	-3.16	9.06	5.60	1.350	1.350	1.350

Verification of complete wall

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 201.38 kPa

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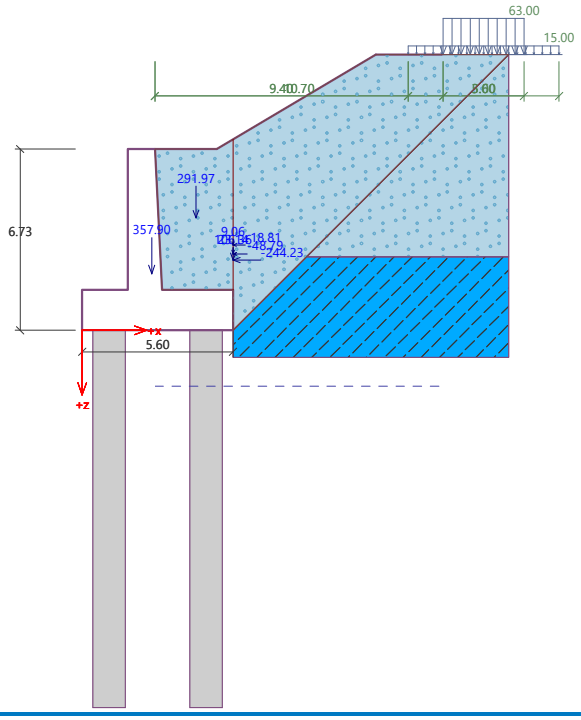
Name : Verification	Stage - analysis : 1 - 1



Bearing capacity of foundation soil (Stage of construction 1)

Forces acting in the center of pile foundation

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	158.73	1067.84	428.29
2	276.74	840.39	428.29

Normal forces acting in the center of pile foundation

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	109.39	788.42	311.83

Input parameters for bearing capacity analysis

Pile spacing s = 3.60 m
Overall number of pile rows n = 2
Loading length l = 7.20 m

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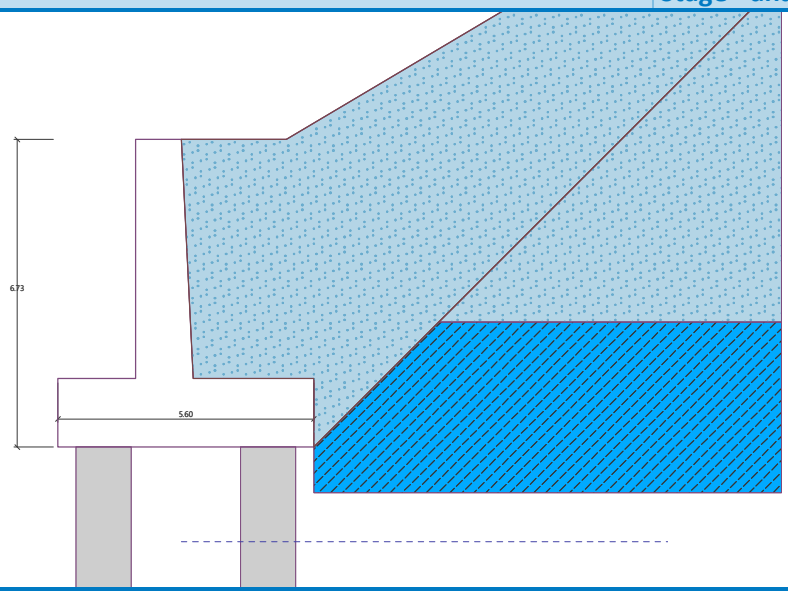
Name : Bearing cap.	Stage - analysis : 1 - -1



Verification of pile group

Verification No. 1

Dimensioning of piles - input data

Analysis carried out with an automatic selection of the most unfavorable LC.
Reinforcement designed for all piles in the group.

Verification of cross section in bending and compression:

Pile diameter: d=1.20m
Reinforcement - 23 pc bars 28.0 mm; cover 90.0 mm
Type of structure (reinforcement ratio) : pile
Reinforcement ratio $\rho = 1.252\ \% > 0.250\ \% = \rho_{min}$
Load : $N_{Ed} = 170.68$ kN (compression) ; $M_{Ed} = 1472.78$ kNm
Bearing capacity : $N_{Rd} = 314.33$ kN; $M_{Rd} = 2712.31$ kNm

Designed pile reinforcement is SATISFACTORY

Verification of cross section in shear:

Shear reinf. - 2 profile 12.0 mm; distance 200.0 mm
$A_{sw} = 1131.0\ mm^2$
Ultimate shear force: $V_{Rd} = 1062.13$ kN > 770.90 kN = V_{Ed}

Cross-section is SATISFACTORY.

only minimal shear reinforcement

Distribution of forces on construction

Depth [m]	Shear force Q [kN]	Bending moment M [kNm]	Normal force N [kN] (tension)	Normal force N [kN] (compression)
0.00	770.90	270.38	-512.85	-2873.48
1.40	490.92	727.05	-499.06	-2807.79
2.80	266.27	1239.42	-469.36	-2650.43
4.20	94.01	1470.10	-437.62	-2467.35
5.60	68.59	1472.78	-403.09	-2268.25
7.00	180.61	1291.56	-362.95	-2036.74
8.40	237.55	992.77	-320.07	-1789.47

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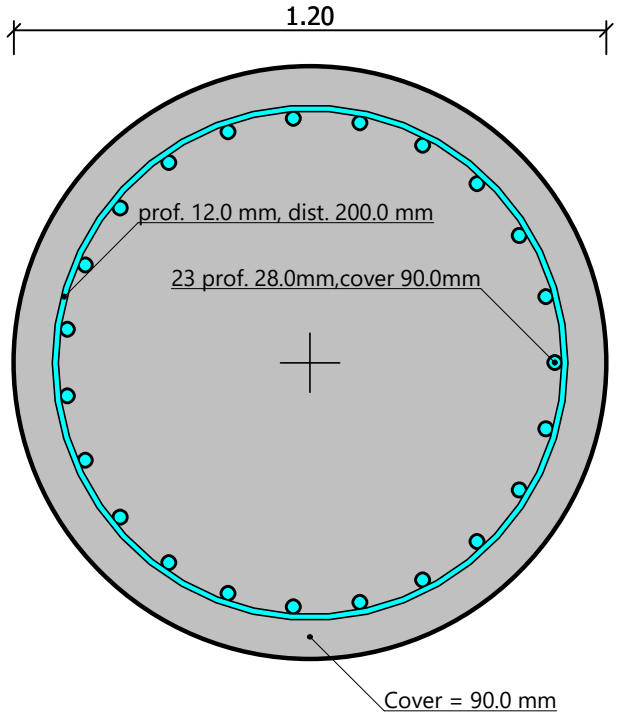
Depth [m]	Shear force Q [kN]	Bending moment M [kNm]	Normal force N [kN] (tension)	Normal force N [kN] (compression)
9.80	244.84	649.56	-277.29	-1542.82
11.20	206.36	328.55	-234.59	-1296.68
12.60	124.41	92.02	-191.97	-1050.96
14.00	0.00	0.00	-170.68	-928.21

Reinforcement drawing



Pile verification

Vertical bear.cap. No.1 - Floating pile

Verification of pile bearing capacity according to NAVFAC DM 7.2 - partial results

Pile base bearing capacity:
The soil under the base is cohesionless
Coefficient of bearing capacity N_q = 10.00
Area of pile transverse cross-section A_p = 1.13E+00 m^2

Plie shaft resistance:

Depth [m]	Thickness [m]	c_{ud} [kPa]	α [–]	K [–]	δ [°]	σ_{or} [kPa]	R_{si} [kN]
0.00	-	-	-	-	-	-	-
2.07	2.07	-	-	1.17	19.50	21.01	61.81
2.07	-	-	-	-	-	-	-
4.87	2.80	-	-	1.17	19.50	56.44	224.60
4.87	-	-	-	-	-	-	-
14.00	9.13	-	-	1.28	22.50	116.97	1937.11

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Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out with automatic selection of the most unfavourable load cases.
Efficiency of pile group $\eta_g = 0.90$
Factor determining critical depth $k_{dc} = 24.00$

Verification of compressive pile:
Most unfavorable load case No. 1. (LC 1)
Pile skin bearing capacity R_s = 2223.52 kN
Pile base bearing capacity R_b = 1676.66 kN

Pile bearing capacity R_c = 3510.16 kN
Ultimate vertical force V_d = 2873.48 kN

$R_c = 3510.16$ kN > 2873.48 kN = V_d

Pile bearing capacity is SATISFACTORY

Dimensioning No. 1 (Stage of construction 1)

Wall stem check - front reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-2.51	147.81	0.57	1.350	1.350	1.000
Pressure at rest	76.96	-1.63	15.39	1.18	1.350	1.350	1.350
Water pressure	0.00	-5.23	0.00	1.00	1.000	1.000	1.000
Voz1	31.08	-2.53	6.22	1.13	1.500	1.500	1.500
Tucanik	13.92	-2.54	2.78	1.13	1.350	1.350	1.350

Wall stem check - front reinf. - V_{Ed}

Wall check at the construction joint 5.23 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 18.0 mm, cover 50.0 mm
Inputted reinforcement area = 1697.3 mm^2
Required reinforcement area = 1625.7 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.26 m

Ultimate shear force $V_{Rd} = 351.50$ kN > 169.31 kN = V_{Ed}
Cross-section is SATISFACTORY.

Wall stem check - front reinf. - M_{Ed}

Wall check at the construction joint 0.10 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 18.0 mm, cover 50.0 mm
Inputted reinforcement area = 1697.3 mm^2
Required reinforcement area = 1625.7 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.01 m

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Reinforcement ratio ρ = 0.18 % > 0.14 % = ρ_{min}
Position of neutral axis x = 0.06 m < 0.58 m = x_{max}
Ultimate moment M_{Rd} = 678.61 kNm > 0.01 kNm = M_{Ed}

Cross-section is SATISFACTORY.

Wall stem check - back reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-2.51	147.81	0.57	1.350	1.350	1.000
Pressure at rest	76.96	-1.63	15.39	1.18	1.350	1.350	1.350
Water pressure	0.00	-5.23	0.00	1.00	1.000	1.000	1.000
Voz1	31.08	-2.53	6.22	1.13	1.500	1.500	1.500
Tucanik	13.92	-2.54	2.78	1.13	1.350	1.350	1.350

Wall stem check - back reinf.

Wall check at the construction joint 5.23 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 18.0 mm, cover 50.0 mm
Inputted reinforcement area = 1697.3 mm^2
Required reinforcement area = 1625.7 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.26 m

Reinforcement ratio ρ = 0.14 % > 0.14 % = ρ_{min}
Position of neutral axis x = 0.06 m < 0.74 m = x_{max}
Ultimate shear force V_{Rd} = 351.50 kN > 169.31 kN = V_{Ed}
Ultimate moment M_{Rd} = 867.76 kNm > 329.31 kNm = M_{Ed}

Cross-section is SATISFACTORY.

Wall jump check

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-2.10	357.90	2.58	1.350
Weight - earth wedge	0.00	-4.18	291.97	4.22	1.350
Active pressure	244.23	-2.61	106.36	5.60	1.350
Water pressure	0.00	-6.73	0.00	5.60	1.350
Voz1	48.79	-2.84	23.14	5.60	1.500
Tucanik	18.81	-3.16	9.06	5.60	1.350

Wall jump check

Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1946.9 mm^2

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Cross-section width = 1.00 m
Cross-section height = 1.50 m

Reinforcement ratio	ρ	=	0.15	%	>	0.14	%	=	ρ_{min}
Position of neutral axis	x	=	0.08	m	<	0.89	m	=	x_{max}
Ultimate shear force	V_{Rd}	=	405.28	kN	>	296.45	kN	=	V_{Ed}
Ultimate moment	M_{Rd}	=	1282.63	kNm	>	256.44	kNm	=	M_{Ed}

Cross-section is SATISFACTORY.

Wall heel check

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-0.75	99.00	4.28	1.350
Weight - earth wedge	0.00	-4.18	291.97	4.22	1.350
Active pressure	244.23	-2.61	106.36	5.60	1.350
Voz1	48.79	-2.84	23.14	5.60	1.500
Tucanik	18.81	-3.16	9.06	5.60	1.350
Contact stress	0.00	0.00	-460.70	4.25	1.000

Wall heel check

Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1946.9 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.50 m

Reinforcement ratio	ρ	=	0.15	%	>	0.14	%	=	ρ_{min}
Position of neutral axis	x	=	0.08	m	<	0.89	m	=	x_{max}
Ultimate shear force	V_{Rd}	=	405.28	kN	>	257.63	kN	=	V_{Ed}
Ultimate moment	M_{Rd}	=	1282.63	kNm	>	585.52	kNm	=	M_{Ed}

Cross-section is SATISFACTORY.

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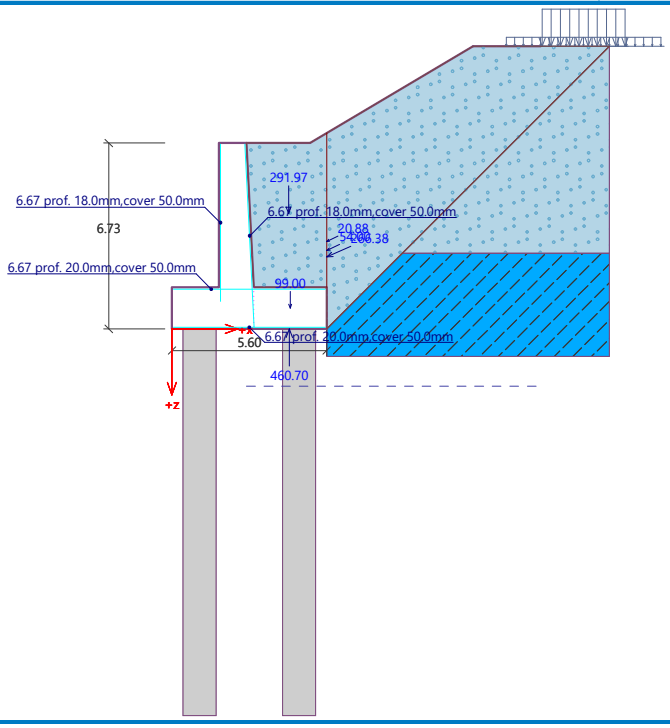
Name : Dimensioning	Stage - analysis : 1 - 1



Input data (Stage of construction 2)

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	4.00	0.00 .. 4.00	Zasip	
2	7.60	4.00 .. 11.60	siSa	
3	14.30	11.60 .. 25.90	SaP	
4	-	25.90 .. ∞	SaP	

Foundation

Type of foundation : pile foundation
Unit weight γ = 25.00 kN/m3

Geometry

Length l = 14.00 m
Offset d = 1.20 m
Diameter x = 0.40 m
Spacing b = 2.40 m

Terrain profile

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	2.30	0.00
3	8.20	-3.50

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No.	Coordinates x [m]	Depth z [m]
4	9.20	-3.50

Origin [0,0] is located in upper right edge of construction.
Positive coordinate +z has downward direction.

Water influence

GWT behind the structure lies at a depth of 8.80 m
Uplift in foot. bottom due to different pressures is not considered.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	No	No	variable	63.00		10.70	3.00	on terrain
2	No	No	permanent	15.00		9.40	5.60	on terrain

No.	Name
1	Voz1
2	Tucanik

Resistance on front face of the structure

Resistance on front face of the structure is not considered.

Earthquake

Factor of horizontal acceleration K_h = 0.0675
Factor of vertical acceleration K_v = 0.0338

Water below the GWT is restricted.

Settings of the stage of construction

Design situation : seismic
The wall is free to move. Active earth pressure is therefore assumed.

Verification No. 1 (Stage of construction 2)

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-2.10	357.90	2.58	1.000	1.000	1.000
Earthq.- constr.	24.16	-2.10	-12.10	2.58	1.000	1.000	1.000
Weight - earth wedge	0.00	-4.18	291.97	4.22	1.000	1.000	1.000
Earthquake - soil wedge	19.71	-4.18	-9.87	4.22	1.000	1.000	1.000
Active pressure	244.23	-2.61	106.36	5.60	1.000	1.000	1.000
Water pressure	0.00	-6.73	0.00	5.60	1.000	1.000	1.000
Earthq.- act.pressure	186.35	-4.75	104.78	5.60	1.000	1.000	1.000
Voz1	48.79	-2.84	23.14	5.60	0.700	0.700	0.700
Tucanik	18.81	-3.16	9.06	5.60	1.000	1.000	1.000

Verification of complete wall

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 234.00 kPa

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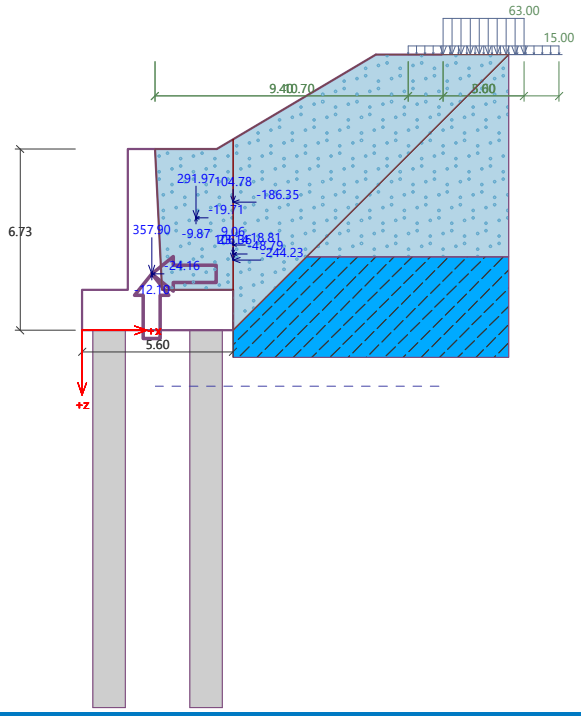
Name : Verification	Stage - analysis : 2 - 1



Warning - allowable range of input data exceeded during earthquake analysis!
The analysis is carried out with the modified value of terrain inclination β. (β=28.02°, β_{modif}=26.00°)

Bearing capacity of foundation soil (Stage of construction 2)

Forces acting in the center of pile foundation

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	823.83	864.30	527.41

Normal forces acting in the center of pile foundation

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	845.91	871.24	542.04

Input parameters for bearing capacity analysis

Pile spacing s = 3.60 m
Overall number of pile rows n = 2
Loading length l = 7.20 m

Verification of pile group

Verification No. 1

Dimensioning of piles - input data

Analysis carried out with an automatic selection of the most unfavorable LC.
Reinforcement designed for all piles in the group.

Verification of cross section in bending and compression:

Pile diameter: d=1.20m
Reinforcement - 23 pc bars 28.0 mm; cover 90.0 mm
Type of structure (reinforcement ratio) : pile
Reinforcement ratio ρ = 1.252 % > 0.250 % = ρ_{min}

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Load : N_{Ed} = 58.78 kN (compression) ; M_{Ed} = 2303.44 kNm
Bearing capacity : N_{Rd} = 67.50 kN; M_{Rd} = 2644.89 kNm
Designed pile reinforcement is SATISFACTORY

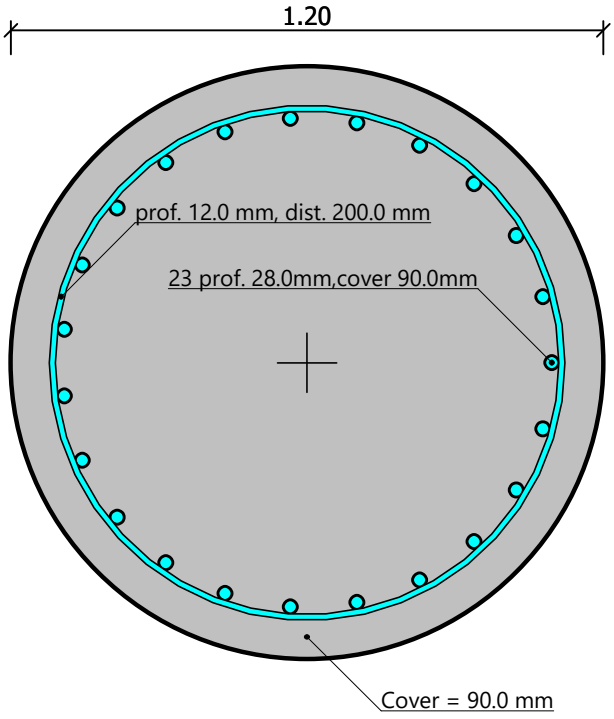
Verification of cross section in shear:

Shear reinf. - 2 profile 12.0 mm; distance 200.0 mm
A_{sw} = 1131.0 mm^2
Ultimate shear force: V_{Rd} = 1062.13 kN > 975.66 kN = V_{Ed}
Cross-section is SATISFACTORY.

Distribution of forces on construction

Depth [m]	Shear force Q [kN]	Bending moment M [kNm]	Normal force N [kN] (tension)	Normal force N [kN] (compression)
0.00	975.66	407.55	-135.67	-3000.80
1.40	585.51	1490.49	-132.11	-2940.68
2.80	277.64	2085.40	-125.03	-2782.93
4.20	45.96	2303.44	-117.97	-2587.96
5.60	149.95	2221.56	-110.31	-2375.86
7.00	291.45	1903.32	-101.40	-2129.20
8.40	358.07	1440.43	-91.88	-1865.72
9.80	357.74	931.92	-82.40	-1602.80
11.20	296.06	467.35	-72.94	-1340.42
12.60	176.34	130.01	-63.50	-1078.55
14.00	0.00	0.00	-58.78	-947.72

Reinforcement drawing



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Pile verification

Vertical bear.cap. No.1 - Floating pile

Verification of pile bearing capacity according to NAVFAC DM 7.2 - partial results

Pile base bearing capacity:
The soil under the base is cohesionless
Coefficient of bearing capacity N_q = 10.00
Area of pile transverse cross-section A_p = 1.13E+00 m^2

Plie shaft resistance:

Depth [m]	Thickness [m]	c_{ud} [kPa]	α [–]	K [–]	δ [°]	σ_{or} [kPa]	R_{si} [kN]
0.00	-	-	-	-	-	-	-
2.07	2.07	-	-	1.17	19.50	21.01	67.99
2.07	-	-	-	-	-	-	-
4.87	2.80	-	-	1.17	19.50	56.44	247.06
4.87	-	-	-	-	-	-	-
14.00	9.13	-	-	1.28	22.50	116.97	2130.82

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out with automatic selection of the most unfavourable load cases.
Efficiency of pile group η_g = 1.00
Factor determining critical depth k_{dc} = 24.00

Verification of compressive pile:
Most unfavorable load case No. 3. (LC 3)
Pile skin bearing capacity R_s = 2445.88 kN
Pile base bearing capacity R_b = 1844.32 kN

Pile bearing capacity R_c = 4290.20 kN
Ultimate vertical force V_d = 3000.80 kN

R_c = 4290.20 kN > 3000.80 kN = V_d

Pile bearing capacity is SATISFACTORY

Dimensioning No. 1 (Stage of construction 2)

Wall stem check - front reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-2.51	147.81	0.57	1.000	1.000	1.000
Earthq.- constr.	9.98	-2.51	-5.00	0.57	1.000	1.000	1.000
Pressure at rest	76.96	-1.63	15.39	1.18	1.000	1.000	1.000
Water pressure	0.00	-5.23	0.00	1.00	1.000	1.000	1.000
Earthquake - pressure at rest	35.66	-2.61	0.00	1.00	1.000	1.000	1.000
Voz1	31.08	-2.53	6.22	1.13	0.700	0.700	0.700

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Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Tucanik	13.92	-2.54	2.78	1.13	1.000	1.000	1.000

Wall stem check - front reinf.

Front reinforcement is not required.

Wall stem check - back reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-2.51	147.81	0.57	1.000	1.000	1.000
Earthq.- constr.	9.98	-2.51	-5.00	0.57	1.000	1.000	1.000
Pressure at rest	76.96	-1.63	15.39	1.18	1.000	1.000	1.000
Water pressure	0.00	-5.23	0.00	1.00	1.000	1.000	1.000
Earthquake - pressure at rest	35.66	-2.61	0.00	1.00	1.000	1.000	1.000
Voz1	31.08	-2.53	6.22	1.13	0.700	0.700	0.700
Tucanik	13.92	-2.54	2.78	1.13	1.000	1.000	1.000

Wall stem check - back reinf.

Wall check at the construction joint 5.23 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 18.0 mm, cover 30.0 mm

Inputted reinforcement area = 1697.3 mm^2
Required reinforcement area = 1652.7 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.26 m

Reinforcement ratio	ρ	=	0.14 %	>	0.14 %	=	ρ_{min}
Position of neutral axis	x	=	0.06 m	<	0.75 m	=	x_{max}
Ultimate shear force	V_{Rd}	=	356.07 kN	>	158.28 kN	=	V_{Ed}
Ultimate moment	M_{Rd}	=	882.52 kNm	>	330.89 kNm	=	M_{Ed}

Cross-section is SATISFACTORY.

Wall jump check

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-2.10	357.90	2.58	1.000
Earthq.- constr.	24.16	-2.10	-12.10	2.58	1.000
Weight - earth wedge	0.00	-4.18	291.97	4.22	1.000
Earthquake - soil wedge	19.71	-4.18	-9.87	4.22	1.000
Active pressure	244.23	-2.61	106.36	5.60	1.000
Water pressure	0.00	-6.73	0.00	5.60	1.000
Earthq.- act.pressure	186.35	-4.75	104.78	5.60	1.000
Voz1	48.79	-2.84	23.14	5.60	0.700

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Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Tucanik	18.81	-3.16	9.06	5.60	1.000

Wall jump check

Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 30.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1973.9 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.50 m

Reinforcement ratio	ρ	=	0.14	%	>	0.14	%	= ρ_{min}
Position of neutral axis	x	=	0.08	m	<	0.90	m	= x_{max}
Ultimate shear force	V_{Rd}	=	409.76	kN	>	385.27	kN	= V_{Ed}
Ultimate moment	M_{Rd}	=	1300.86	kNm	>	350.53	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

Wall heel check

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-0.75	99.00	4.28	1.000
Weight - earth wedge	0.00	-4.18	291.97	4.22	1.000
Active pressure	244.23	-2.61	106.36	5.60	1.000
Voz1	48.79	-2.84	23.14	5.60	0.700
Tucanik	18.81	-3.16	9.06	5.60	1.000
Contact stress	0.00	0.00	-187.27	3.82	1.000

Wall heel check

Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 30.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1973.9 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.50 m

Reinforcement ratio	ρ	=	0.14	%	>	0.14	%	= ρ_{min}
Position of neutral axis	x	=	0.08	m	<	0.90	m	= x_{max}
Ultimate shear force	V_{Rd}	=	409.76	kN	>	335.31	kN	= V_{Ed}
Ultimate moment	M_{Rd}	=	1300.86	kNm	>	685.71	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

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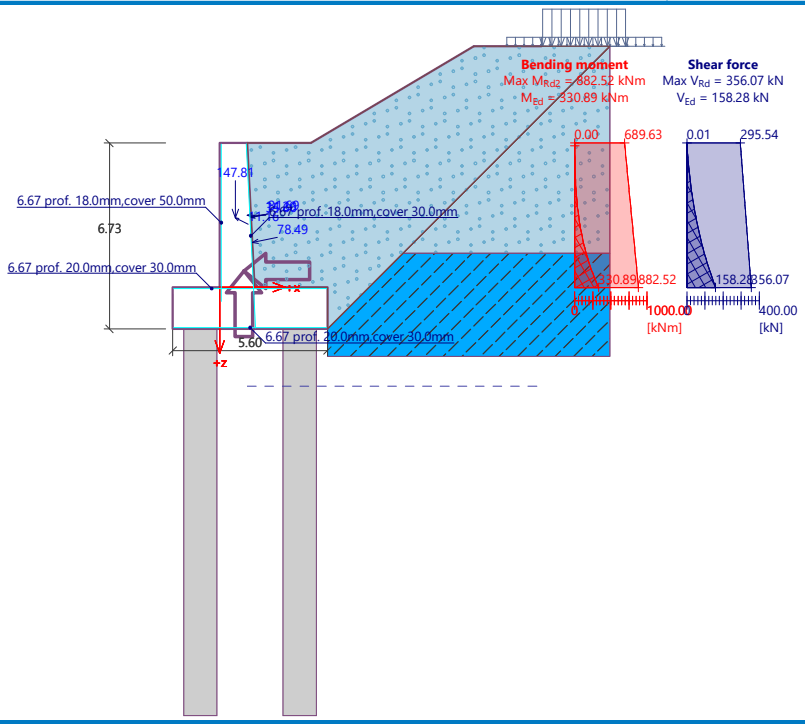
Name : Dimensioning	Stage - analysis : 2 - 1



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Потпорни зидови уз галерију на km 78+377 пруге

Кампада 6

Retaining Walls adjacent to the gallery at km 78+377 of the railway line

Section 6

Cantilever wall analysis

Input data

Project

Task : Пројекат потпорних конструкција
Part : Деоница: Нови Сад - Суботица - Државна граница (Келебија)
Description : Потпорни зид на км 78+399 пруге - Кампада 6
Date : 14.4.2021.

Settings

Standard - EN 1997 - PP2 - SRB

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : user-defined
Article 3.1.6 : $\alpha_{cc} = 0.85$

Wall analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Caquot-Kerisel
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Consider always vertical
Base key : The base key is considered as inclined footing bottom
Allowable eccentricity : 0.170
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

Partial factors on actions (A)					
Permanent design situation					
		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.35	[–]	1.00	[–]
Variable actions :	γ_Q =	1.50	[–]	0.00	[–]
Water load :	γ_w =	1.35	[–]		

Partial factors for resistances (R)			
Permanent design situation			
Partial factor on overturning :	γ_{Rv} =	1.40	[–]
Partial factor on sliding resistance :	γ_{Rh} =	1.10	[–]
Partial factor on bearing capacity :	γ_{Re} =	1.40	[–]

Partial factors for variable actions			
Permanent design situation			
Factor for combination value :	ψ_0 =	0.70	[–]
Factor for frequent value :	ψ_1 =	0.50	[–]
Factor for quasi-permanent value :	ψ_2 =	0.30	[–]

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Partial factors on actions (A)					
Seismic design situation					
		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.00	[–]	1.00	[–]
Variable actions :	γ_Q =	1.00	[–]	0.00	[–]
Water load :	γ_w =	1.00	[–]		

Partial factors for resistances (R)			
Seismic design situation			
Partial factor on overturning :	γ_{Rv} =	1.40	[–]
Partial factor on sliding resistance :	γ_{Rh} =	1.25	[–]
Partial factor on bearing capacity :	γ_{Re} =	1.40	[–]

Material of structure

Unit weight γ = 25.00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete: C 25/30
Cylinder compressive strength f_{ck} = 25.00 MPa
Tensile strength f_{ctm} = 2.60 MPa

Longitudinal steel: B500B
Yield strength f_{yk} = 500.00 MPa

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0.00	0.00
2	0.21	4.13
3	2.90	4.13
4	2.90	5.63
5	-2.70	5.63
6	-2.70	4.13
7	-1.00	4.13
8	-1.00	0.00

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 12.95 m^2.

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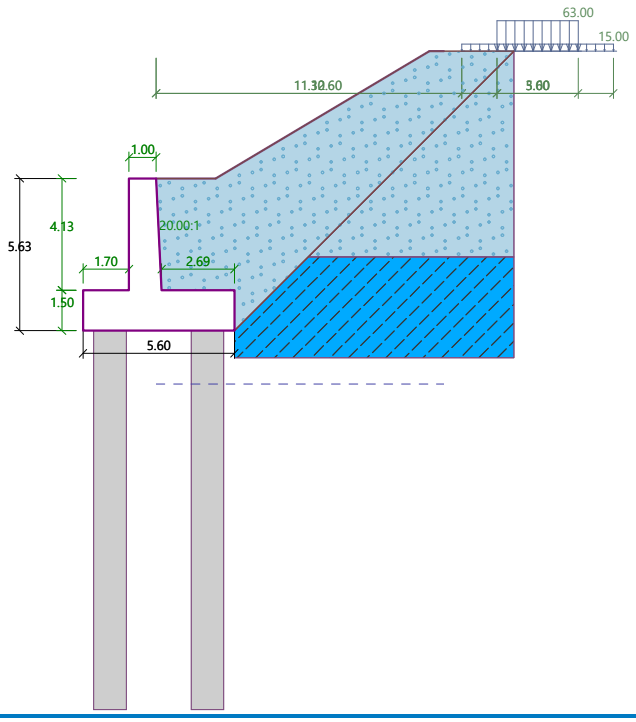
Name : Geometry	Stage - analysis : 1 - 0



Basic soil parameters

No.	Name	Pattern	ϕ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]	γ_{su} [kN/m³]	δ [°]
1	Zasip		30.00	0.00	20.00	10.00	10.00
2	siSa		26.00	12.00	20.30	10.30	8.00
3	SaP		30.00	5.00	20.10	10.10	10.00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	ϕ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
1	Zasip		cohesive	-	0.20	-	-
2	siSa		cohesive	-	0.30	-	-
3	SaP		cohesive	-	0.28	-	-

Soil parameters

Zasip

Unit weight : $\gamma = 20.00$ kN/m³
Stress-state : effective
Angle of internal friction : $\phi_{ef} = 30.00$ °
Cohesion of soil : $c_{ef} = 0.00$ kPa
Angle of friction struc.-soil : $\delta = 10.00$ °
Soil : cohesive
Poisson's ratio : $\nu = 0.20$

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Saturated unit weight : γ_{sat} = 20.00 kN/m^3

siSa

Unit weight : γ = 20.30 kN/m^3
Stress-state : effective
Angle of internal friction : ϕ_{ef} = 26.00 °
Cohesion of soil : c_{ef} = 12.00 kPa
Angle of friction struc.-soil : δ = 8.00 °
Soil : cohesive
Poisson's ratio : ν = 0.30
Saturated unit weight : γ_{sat} = 20.30 kN/m^3

SaP

Unit weight : γ = 20.10 kN/m^3
Stress-state : effective
Angle of internal friction : ϕ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 5.00 kPa
Angle of friction struc.-soil : δ = 10.00 °
Soil : cohesive
Poisson's ratio : ν = 0.28
Saturated unit weight : γ_{sat} = 20.10 kN/m^3

Backfill

Assigned soil : Zasip
Slope = 45.00 °

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	2.90	0.00 .. 2.90	Zasip	
2	7.60	2.90 .. 10.50	siSa	
3	14.30	10.50 .. 24.80	SaP	
4	-	24.80 .. ∞	SaP	

Foundation

Type of foundation : pile foundation
Unit weight γ = 25.00 kN/m^3

Geometry

Length l = 14.00 m
Offset d = 1.20 m
Diameter x = 0.40 m
Spacing b = 2.40 m

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Terrain profile

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	2.20	0.00
3	10.10	-4.70
4	11.10	-4.70

Origin [0,0] is located in upper right edge of construction.
Positive coordinate +z has downward direction.

Water influence

GWT behind the structure lies at a depth of 7.60 m
Uplift in foot. bottom due to different pressures is not considered.

Input surface surcharges

No.	Surcharge		Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
	new	change						
1	Yes		variable	63.00		12.60	3.00	on terrain
2	Yes		permanent	15.00		11.30	5.60	on terrain

No.	Name
1	Voz1
2	Tucanik

Resistance on front face of the structure

Resistance on front face of the structure is not considered.

Settings of the stage of construction

Design situation : permanent
The wall is free to move. Active earth pressure is therefore assumed.

Verification No. 1 (Stage of construction 1)

Active pressure behind the structure - partial results

Layer No.	Thickness [m]	α [°]	ϕ_d [°]	c_d [kPa]	γ [kN/m³]	δ_d [°]	K_a	Comment
1	0.41	0.00	30.00	0.00	20.00	30.00	0.886	
2	1.00	0.00	30.00	0.00	20.00	30.00	0.886	
3	0.75	0.00	30.00	0.00	20.00	30.00	0.886	
4	1.15	0.00	30.00	0.00	20.00	30.00	0.297	
5	1.23	0.00	30.00	0.00	20.00	30.00	0.297	
6	1.50	0.00	30.00	0.00	20.00	10.00	0.308	

Active pressure distribution behind the structure (without surcharge)

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.41	0.00	0.00	0.00	0.00	0.00
	0.00	8.29	0.00	7.35	6.36	3.67

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Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
2	0.00	8.29	0.00	7.35	6.36	3.67
	1.00	28.29	0.00	25.07	21.71	12.54
3	1.00	28.29	0.00	25.07	21.71	12.54
	1.75	43.23	0.00	38.32	33.19	19.16
4	1.75	43.23	0.00	38.32	33.19	19.16
	2.90	66.29	0.00	45.17	39.12	22.58
5	2.90	66.29	0.00	45.17	39.12	22.58
	4.13	90.89	0.00	52.48	45.45	26.24
6	4.13	90.89	0.00	54.48	53.65	9.46
	5.63	120.89	0.00	63.73	62.76	11.07

Water pressure distribution

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.41	0.00	0.00
2	0.00	0.00	0.00
3	1.00	0.00	0.00
4	1.75	0.00	0.00
5	2.90	0.00	0.00
6	4.13	0.00	0.00
7	5.63	0.00	0.00

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-1.72	323.78	2.61	1.000	1.000	1.350
Weight - earth wedge	0.00	-3.62	233.61	4.21	1.000	1.000	1.350
Active pressure	216.85	-2.19	90.19	5.60	1.350	1.350	1.350
Water pressure	0.00	-5.63	0.00	5.60	1.000	1.000	1.350
Voz1	38.14	-2.20	16.75	5.60	1.500	1.500	1.500
Tucanik	15.21	-2.57	6.95	5.60	1.350	1.350	1.350

Verification of complete wall

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 163.69 kPa

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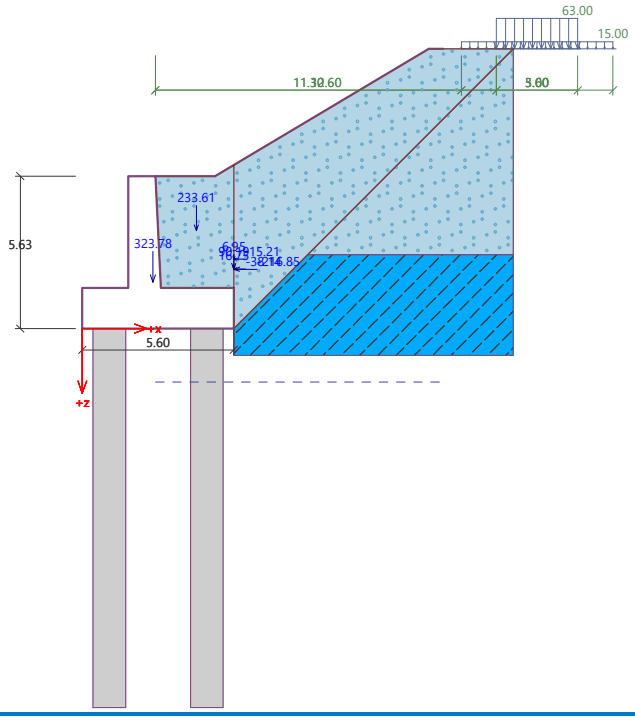
Name : Verification	Stage - analysis : 1 - 1



Bearing capacity of foundation soil (Stage of construction 1)

Forces acting in the center of pile foundation

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	22.05	908.74	370.50
2	115.71	713.65	370.50

Normal forces acting in the center of pile foundation

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	12.20	671.28	270.21

Input parameters for bearing capacity analysis

Pile spacing $s = 3.60$ m
Overall number of pile rows $n = 2$
Loading length $l = 7.20$ m

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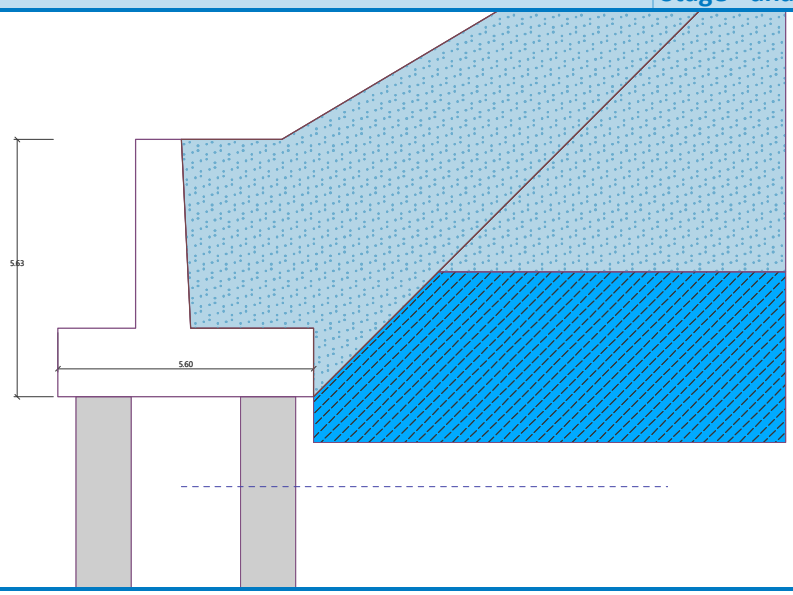
Name : Bearing cap.	Stage - analysis : 1 - -1



Verification of pile group

Verification No. 1

Dimensioning of piles - input data

Analysis carried out with an automatic selection of the most unfavorable LC.
Reinforcement designed for all piles in the group.

Verification of cross section in bending and compression:

Pile diameter: d=1.20m
Reinforcement - 18 pc bars 25.0 mm; cover 90.0 mm
Type of structure (reinforcement ratio) : pile
Reinforcement ratio $\rho = 0.781\ \% > 0.250\ \% = \rho_{min}$
Load : $N_{Ed} = 149.94$ kN (compression) ; $M_{Ed} = 1165.50$ kNm
Bearing capacity : $N_{Rd} = 235.70$ kN; $M_{Rd} = 1832.13$ kNm

Designed pile reinforcement is SATISFACTORY

Verification of cross section in shear:

Shear reinf. - 2 profile 12.0 mm; distance 150.0 mm
$A_{sw} = 1508.0\ mm^2$
Ultimate shear force: $V_{Rd} = 1416.18$ kN > 666.90 kN = V_{Ed}

Cross-section is SATISFACTORY.

only minimal shear reinforcement

Distribution of forces on construction

Depth [m]	Shear force Q [kN]	Bending moment M [kNm]	Normal force N [kN] (tension)	Normal force N [kN] (compression)
0.00	666.90	407.40	-443.56	-2439.87
1.40	432.97	455.79	-430.55	-2370.14
2.80	244.08	915.29	-404.01	-2225.57
4.20	98.23	1137.28	-377.00	-2076.20
5.60	40.16	1165.50	-347.63	-1913.80
7.00	137.15	1035.72	-313.48	-1724.95
8.40	188.07	802.97	-277.00	-1523.20

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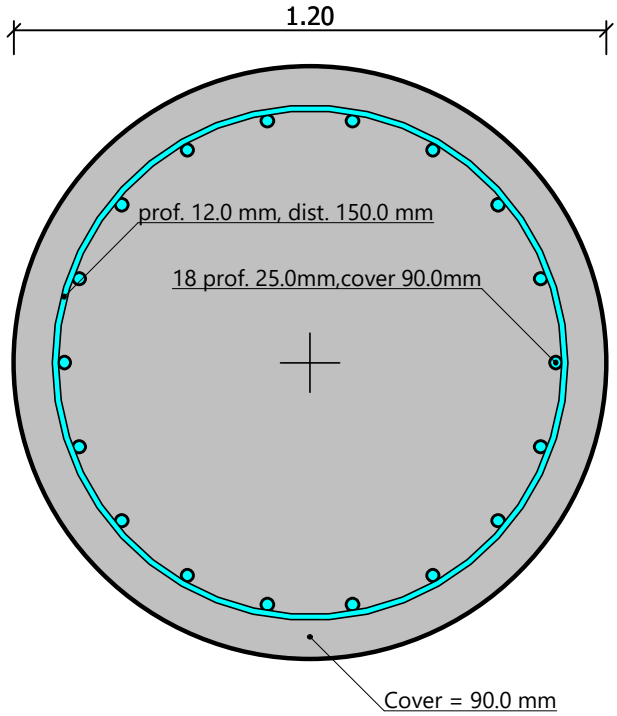
Depth [m]	Shear force Q [kN]	Bending moment M [kNm]	Normal force N [kN] (tension)	Normal force N [kN] (compression)
9.80	197.28	528.57	-240.60	-1321.90
11.20	167.92	268.57	-204.29	-1121.04
12.60	101.89	75.49	-168.04	-920.58
14.00	0.00	0.00	-149.94	-820.43

Reinforcement drawing



Pile verification

Vertical bear.cap. No.1 - Floating pile

Verification of pile bearing capacity according to NAVFAC DM 7.2 - partial results

Pile base bearing capacity:
The soil under the base is cohesionless
Coefficient of bearing capacity N_q = 10.00
Area of pile transverse cross-section A_p = 1.13E+00 m^2

Plie shaft resistance:

Depth [m]	Thickness [m]	c_{ud} [kPa]	α [–]	K [–]	δ [°]	σ_{or} [kPa]	R_{si} [kN]
0.00	-	-	-	-	-	-	-
1.97	1.97	-	-	1.17	19.50	20.00	55.98
1.97	-	-	-	-	-	-	-
4.87	2.90	-	-	1.17	19.50	54.93	226.38
4.87	-	-	-	-	-	-	-
14.00	9.13	-	-	1.28	22.50	115.97	1920.55

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Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out with automatic selection of the most unfavourable load cases.
Efficiency of pile group $\eta_g = 0.90$
Factor determining critical depth $k_{dc} = 24.00$

Verification of compressive pile:
Most unfavorable load case No. 1. (LC 1)
Pile skin bearing capacity R_s = 2202.91 kN
Pile base bearing capacity R_b = 1666.38 kN

Pile bearing capacity R_c = 3482.36 kN
Ultimate vertical force V_d = 2439.87 kN

$R_c = 3482.36$ kN > 2439.87 kN = V_d

Pile bearing capacity is SATISFACTORY

Dimensioning No. 1 (Stage of construction 1)

Wall stem check - front reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-2.00	113.87	0.55	1.350	1.350	1.000
Pressure at rest	45.26	-1.32	9.05	1.14	1.350	1.350	1.350
Water pressure	0.00	-4.13	0.00	1.00	1.000	1.000	1.000
Voz1	21.49	-2.01	4.30	1.11	1.500	1.500	1.500
Tucanik	9.62	-2.02	1.92	1.11	1.350	1.350	1.350

Wall stem check - front reinf. - V_{Ed}

Wall check at the construction joint 4.13 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1550.0 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.21 m

Ultimate shear force $V_{Rd} = 338.65$ kN > 106.33 kN = V_{Ed}
Cross-section is SATISFACTORY.

Wall stem check - front reinf. - M_{Ed}

Wall check at the construction joint 0.08 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1550.0 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.00 m

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Reinforcement ratio ρ = 0.22 % > 0.14 % = ρ_{min}
Position of neutral axis x = 0.07 m < 0.58 m = x_{max}
Ultimate moment M_{Rd} = 830.63 kNm > 0.01 kNm = M_{Ed}

Cross-section is SATISFACTORY.

Wall stem check - back reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-2.00	113.87	0.55	1.350	1.350	1.000
Pressure at rest	45.26	-1.32	9.05	1.14	1.350	1.350	1.350
Water pressure	0.00	-4.13	0.00	1.00	1.000	1.000	1.000
Voz1	21.49	-2.01	4.30	1.11	1.500	1.500	1.500
Tucanik	9.62	-2.02	1.92	1.11	1.350	1.350	1.350

Wall stem check - back reinf.

Wall check at the construction joint 4.13 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1550.0 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.21 m

Reinforcement ratio ρ = 0.18 % > 0.14 % = ρ_{min}
Position of neutral axis x = 0.07 m < 0.71 m = x_{max}
Ultimate shear force V_{Rd} = 338.65 kN > 106.33 kN = V_{Ed}
Ultimate moment M_{Rd} = 1015.02 kNm > 168.07 kNm = M_{Ed}

Cross-section is SATISFACTORY.

Wall jump check

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-1.72	323.78	2.61	1.350
Weight - earth wedge	0.00	-3.62	233.61	4.21	1.350
Active pressure	216.85	-2.19	90.19	5.60	1.350
Water pressure	0.00	-5.63	0.00	5.60	1.350
Voz1	38.14	-2.20	16.75	5.60	1.500
Tucanik	15.21	-2.57	6.95	5.60	1.350

Wall jump check

Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1946.9 mm^2

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Cross-section width = 1.00 m
Cross-section height = 1.50 m

Reinforcement ratio	ρ	=	0.15	%	>	0.14	%	=	ρ_{min}
Position of neutral axis	x	=	0.08	m	<	0.89	m	=	x_{max}
Ultimate shear force	V_{Rd}	=	405.28	kN	>	216.93	kN	=	V_{Ed}
Ultimate moment	M_{Rd}	=	1282.63	kNm	>	184.96	kNm	=	M_{Ed}

Cross-section is SATISFACTORY.

Wall heel check

Active pressure behind the structure - partial results

Layer No.	Thickness [m]	α [°]	ϕ_d [°]	c_d [kPa]	γ [kN/m³]	δ_d [°]	K_a	Comment
1	0.41	0.00	30.00	0.00	20.00	30.00	0.886	
2	1.00	0.00	30.00	0.00	20.00	30.00	0.886	
3	0.75	0.00	30.00	0.00	20.00	30.00	0.886	
4	1.15	0.00	30.00	0.00	20.00	30.00	0.297	
5	1.23	0.00	30.00	0.00	20.00	30.00	0.297	
6	1.50	0.00	30.00	0.00	20.00	10.00	0.308	

Active pressure distribution behind the structure (without surcharge)

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.41	0.00	0.00	0.00	0.00	0.00
	0.00	8.29	0.00	7.35	6.36	3.67
2	0.00	8.29	0.00	7.35	6.36	3.67
	1.00	28.29	0.00	25.07	21.71	12.54
3	1.00	28.29	0.00	25.07	21.71	12.54
	1.75	43.23	0.00	38.32	33.19	19.16
4	1.75	43.23	0.00	38.32	33.19	19.16
	2.90	66.29	0.00	45.17	39.12	22.58
5	2.90	66.29	0.00	45.17	39.12	22.58
	4.13	90.89	0.00	52.48	45.45	26.24
6	4.13	90.89	0.00	54.48	53.65	9.46
	5.63	120.89	0.00	63.73	62.76	11.07

Water pressure distribution

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.41	0.00	0.00
2	0.00	0.00	0.00
3	1.00	0.00	0.00
4	1.75	0.00	0.00
5	2.90	0.00	0.00
6	4.13	0.00	0.00

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Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
7	5.63	0.00	0.00

Pressure distribution from surcharge - Voz1

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.41	0.00	0.00
2	0.00	0.00	0.00
3	0.00	0.00	0.00
4	1.00	0.00	0.00
5	1.32	0.00	0.00
6	1.32	9.88	5.70
7	1.75	9.57	5.53
8	2.90	8.76	5.06
9	4.13	7.89	4.56
10	4.13	9.31	1.64
11	5.63	8.22	1.45

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-0.75	100.88	4.25	1.350
Weight - earth wedge	0.00	-3.62	233.61	4.21	1.350
Active pressure	216.85	-2.19	90.19	5.60	1.350
Voz1	38.14	-2.20	16.75	5.60	1.500
Tucanik	15.21	-2.57	6.95	5.60	1.350
Contact stress	0.00	0.00	-431.32	4.25	1.000

Wall heel check

Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1946.9 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.50 m

Reinforcement ratio	ρ	=	0.15	%	>	0.14	%	= ρ_{min}
Position of neutral axis	x	=	0.08	m	<	0.89	m	= x_{max}
Ultimate shear force	V_{Rd}	=	405.28	kN	>	176.50	kN	= V_{Ed}
Ultimate moment	M_{Rd}	=	1282.63	kNm	>	437.91	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

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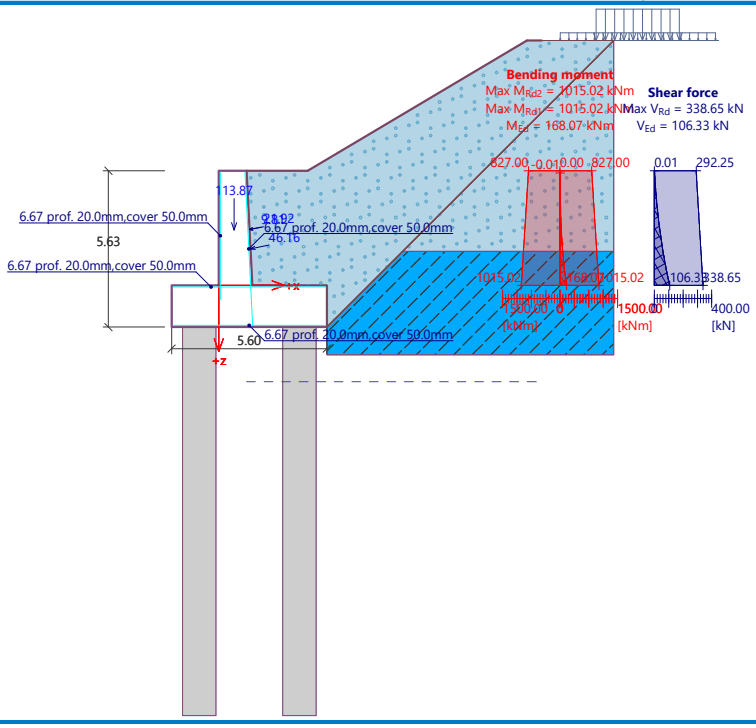
Name : Dimensioning	Stage - analysis : 1 - 1



Input data (Stage of construction 2)

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	2.90	0.00 .. 2.90	Zasip	
2	7.60	2.90 .. 10.50	siSa	
3	14.30	10.50 .. 24.80	SaP	
4	-	24.80 .. ∞	SaP	

Foundation

Type of foundation : pile foundation
Unit weight γ = 25.00 kN/m3

Geometry

Length l = 14.00 m
Offset d = 1.20 m
Diameter x = 0.40 m
Spacing b = 2.40 m

Terrain profile

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	2.20	0.00
3	10.10	-4.70

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No.	Coordinates x [m]	Depth z [m]
4	11.10	-4.70

Origin [0,0] is located in upper right edge of construction.
Positive coordinate +z has downward direction.

Water influence

GWT behind the structure lies at a depth of 7.60 m
Uplift in foot. bottom due to different pressures is not considered.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	No	No	variable	63.00		12.60	3.00	on terrain
2	No	No	permanent	15.00		11.30	5.60	on terrain

No.	Name
1	Voz1
2	Tucanik

Resistance on front face of the structure

Resistance on front face of the structure is not considered.

Earthquake

Factor of horizontal acceleration K_h = 0.0675
Factor of vertical acceleration K_v = 0.0338

Water below the GWT is restricted.

Settings of the stage of construction

Design situation : seismic
The wall is free to move. Active earth pressure is therefore assumed.

Verification No. 1 (Stage of construction 2)

Active pressure behind the structure - partial results

Layer No.	Thickness [m]	α [°]	ϕ_d [°]	c_d [kPa]	γ [kN/m³]	δ_d [°]	K_a	Comment
1	0.41	0.00	30.00	0.00	20.00	30.00	0.886	
2	1.00	0.00	30.00	0.00	20.00	30.00	0.886	
3	0.75	0.00	30.00	0.00	20.00	30.00	0.886	
4	1.15	0.00	30.00	0.00	20.00	30.00	0.297	
5	1.23	0.00	30.00	0.00	20.00	30.00	0.297	
6	1.50	0.00	30.00	0.00	20.00	10.00	0.308	

Active pressure distribution behind the structure (without surcharge)

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.41	0.00	0.00	0.00	0.00	0.00
	0.00	8.29	0.00	7.35	6.36	3.67

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Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
2	0.00	8.29	0.00	7.35	6.36	3.67
	1.00	28.29	0.00	25.07	21.71	12.54
3	1.00	28.29	0.00	25.07	21.71	12.54
	1.75	43.23	0.00	38.32	33.19	19.16
4	1.75	43.23	0.00	38.32	33.19	19.16
	2.90	66.29	0.00	45.17	39.12	22.58
5	2.90	66.29	0.00	45.17	39.12	22.58
	4.13	90.89	0.00	52.48	45.45	26.24
6	4.13	90.89	0.00	54.48	53.65	9.46
	5.63	120.89	0.00	63.73	62.76	11.07

Earthquake effects (active earth pressure) - partial results

Layer No.	Thickness [m]	ϕ_d [°]	β [°]	ψ [°]	K_a	K_{ae}	K_{ae}-K_a	Comment
1	0.41	30.00	30.00(26.00)	4.00	0.530	0.977	0.447	MODIFIED
2	1.00	30.00	30.00(26.00)	4.00	0.530	0.977	0.447	MODIFIED
3	0.75	30.00	30.00(26.00)	4.00	0.530	0.977	0.447	MODIFIED
4	1.15	30.00	30.00(26.00)	4.00	0.530	0.977	0.447	MODIFIED
5	1.23	30.00	30.00(26.00)	4.00	0.530	0.977	0.447	MODIFIED
6	1.50	30.00	30.00(26.00)	4.00	0.508	0.835	0.327	MODIFIED

Earthquake effects (active earth pressure)

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_D [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vertical comp. [kPa]
1	-0.41	0.00	116.80	52.19	45.19	26.09
	0.00	8.01	108.79	48.61	42.10	24.30
2	0.00	8.01	108.79	48.61	42.10	24.30
	1.00	27.33	89.47	39.97	34.62	19.99
3	1.00	27.33	89.47	39.97	34.62	19.99
	1.75	41.77	75.03	33.52	29.03	16.76
4	1.75	41.77	75.03	33.52	29.03	16.76
	2.90	64.05	52.75	23.57	20.41	11.79
5	2.90	64.05	52.75	23.57	20.41	11.79
	4.13	87.82	28.99	12.95	11.22	6.48
6	4.13	87.82	28.99	9.48	9.33	1.65
	5.63	116.80	0.00	0.00	0.00	0.00

Water pressure distribution

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.41	0.00	0.00
2	0.00	0.00	0.00

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Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
3	1.00	0.00	0.00
4	1.75	0.00	0.00
5	2.90	0.00	0.00
6	4.13	0.00	0.00
7	5.63	0.00	0.00

Pressure distribution from surcharge - Voz1

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.41	0.00	0.00
2	0.00	0.00	0.00
3	0.00	0.00	0.00
4	1.00	0.00	0.00
5	1.32	0.00	0.00
6	1.32	9.88	5.70
7	1.75	9.57	5.53
8	2.90	8.76	5.06
9	4.13	7.89	4.56
10	4.13	9.31	1.64
11	5.63	8.22	1.45

Pressure distribution from surcharge - Tucanik

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.41	0.00	0.00
2	0.00	0.00	0.00
3	0.00	0.00	0.00
4	0.57	0.00	0.00
5	0.57	3.29	1.90
6	1.00	3.21	1.86
7	1.32	3.16	1.83
8	1.75	3.09	1.78
9	2.90	2.89	1.67
10	4.13	2.69	1.55
11	4.13	3.17	0.56
12	5.63	2.91	0.51

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-1.72	323.78	2.61	1.000	1.000	1.000
Earthq.- constr.	21.86	-1.72	-10.94	2.61	1.000	1.000	1.000

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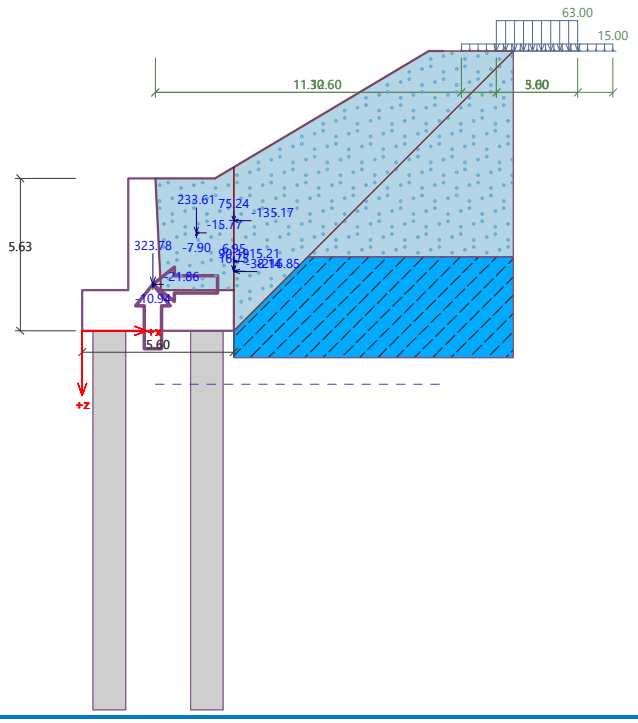
Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - earth wedge	0.00	-3.62	233.61	4.21	1.000	1.000	1.000
Earthquake - soil wedge	15.77	-3.62	-7.90	4.21	1.000	1.000	1.000
Active pressure	216.85	-2.19	90.19	5.60	1.000	1.000	1.000
Water pressure	0.00	-5.63	0.00	5.60	1.000	1.000	1.000
Earthq.- act.pressure	135.17	-4.06	75.24	5.60	1.000	1.000	1.000
Voz1	38.14	-2.20	16.75	5.60	0.700	0.700	0.700
Tucanik	15.21	-2.57	6.95	5.60	1.000	1.000	1.000

Verification of complete wall

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 165.24 kPa

Name : Verification	Stage - analysis : 2 - 1



Warning - allowable range of input data exceeded during earthquake analysis!
The analysis is carried out with the modified value of terrain inclination β. (β=30.00°, β_{modif}=26.00°)

Bearing capacity of foundation soil (Stage of construction 2)

Forces acting in the center of pile foundation

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	443.25	722.65	431.56

Normal forces acting in the center of pile foundation

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	454.40	727.68	443.01

Input parameters for bearing capacity analysis

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Pile spacing s = 3.60 m
Overall number of pile rows n = 2
Loading length l = 7.20 m

Verification of pile group

Verification No. 1

Dimensioning of piles - input data

Analysis carried out with an automatic selection of the most unfavorable LC.
Reinforcement designed for all piles in the group.

Verification of cross section in bending and compression:

Pile diameter: d=1.20m
Reinforcement - 18 pc bars 25.0 mm; cover 90.0 mm
Type of structure (reinforcement ratio) : pile
Reinforcement ratio $\rho = 0.781\ \% > 0.250\ \% = \rho_{min}$
Load : $N_{Ed} = 79.25$ kN (compression) ; $M_{Ed} = 1638.19$ kNm
Bearing capacity : $N_{Rd} = 85.94$ kN; $M_{Rd} = 1776.48$ kNm

Designed pile reinforcement is SATISFACTORY

Verification of cross section in shear:

Shear reinf. - 2 profile 12.0 mm; distance 150.0 mm
$A_{sw} = 1508.0\ mm^2$
Ultimate shear force: $V_{Rd} = 1416.18$ kN > 797.40 kN = V_{Ed}

Cross-section is SATISFACTORY.

Distribution of forces on construction

Depth [m]	Shear force Q [kN]	Bending moment M [kNm]	Normal force N [kN] (tension)	Normal force N [kN] (compression)
0.00	797.40	8.89	-194.66	-2424.98
1.40	494.11	903.44	-189.33	-2359.04
2.80	252.75	1419.21	-178.70	-2218.01
4.20	69.35	1638.19	-168.11	-2068.09
5.60	87.71	1618.33	-156.60	-1905.06
7.00	203.50	1407.28	-143.23	-1715.49
8.40	260.96	1075.73	-128.95	-1513.03
9.80	265.96	701.04	-114.71	-1311.02
11.20	222.71	353.52	-100.50	-1109.38
12.60	133.70	98.78	-86.33	-908.11
14.00	0.00	0.00	-79.25	-807.56

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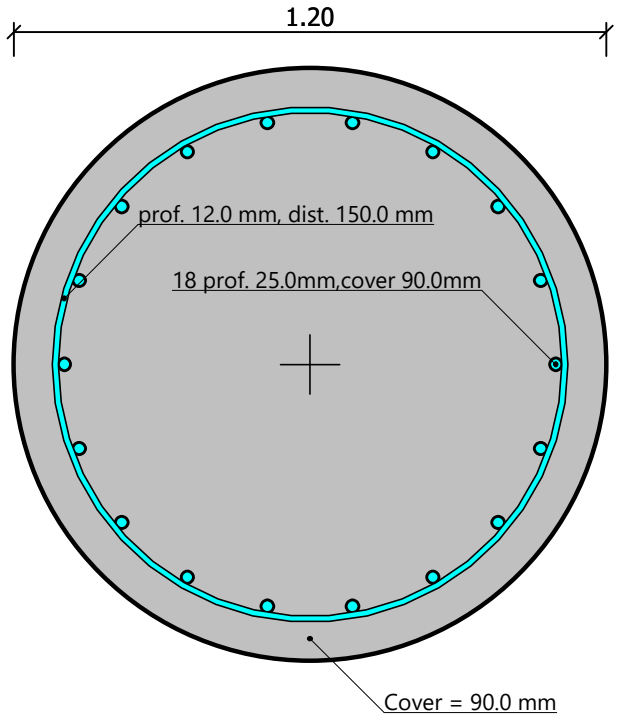
Reinforcement drawing



Pile verification

Vertical bear.cap. No.1 - Floating pile

Verification of pile bearing capacity according to NAVFAC DM 7.2 - partial results

Pile base bearing capacity:
The soil under the base is cohesionless
Coefficient of bearing capacity N_q = 10.00
Area of pile transverse cross-section A_p = 1.13E+00 m^2

Plie shaft resistance:

Depth [m]	Thickness [m]	c_{ud} [kPa]	α [–]	K [–]	δ [°]	σ_{or} [kPa]	R_{si} [kN]
0.00	-	-	-	-	-	-	-
1.97	1.97	-	-	1.17	19.50	20.00	61.58
1.97	-	-	-	-	-	-	-
4.87	2.90	-	-	1.17	19.50	54.93	249.02
4.87	-	-	-	-	-	-	-
14.00	9.13	-	-	1.28	22.50	115.97	2112.60

Verification of bearing capacity : NAVFAC DM 7.2

Analysis carried out with automatic selection of the most unfavourable load cases.
Efficiency of pile group η_g = 1.00
Factor determining critical depth k_{dc} = 24.00

Verification of compressive pile:
Most unfavorable load case No. 3. (LC 3)
Pile skin bearing capacity R_s = 2423.20 kN
Pile base bearing capacity R_b = 1833.01 kN

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Pile bearing capacity R_c = 4256.22 kN
Ultimate vertical force V_d = 2424.98 kN

R_c = 4256.22 kN > 2424.98 kN = V_d

Pile bearing capacity is SATISFACTORY

Dimensioning No. 1 (Stage of construction 2)

Wall stem check - front reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-2.00	113.87	0.55	1.000	1.000	1.000
Earthq.- constr.	7.69	-2.00	-3.85	0.55	1.000	1.000	1.000
Pressure at rest	45.26	-1.32	9.05	1.14	1.000	1.000	1.000
Water pressure	0.00	-4.13	0.00	1.00	1.000	1.000	1.000
Earthquake - pressure at rest	22.24	-2.06	0.00	1.00	1.000	1.000	1.000
Voz1	21.49	-2.01	4.30	1.11	0.700	0.700	0.700
Tucanik	9.62	-2.02	1.92	1.11	1.000	1.000	1.000

Wall stem check - front reinf. - V_{Ed}

Wall check at the construction joint 4.13 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1550.0 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.21 m

Ultimate shear force V_{Rd} = 338.65 kN > 99.85 kN = V_{Ed}
Cross-section is SATISFACTORY.

Wall stem check - front reinf. - M_{Ed}

Wall check at the construction joint 0.08 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1550.0 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.00 m

Reinforcement ratio ρ = 0.22 % > 0.14 % = ρ_{min}
Position of neutral axis x = 0.07 m < 0.58 m = x_{max}
Ultimate moment M_{Rd} = 830.63 kNm > 0.00 kNm = M_{Ed}

Cross-section is SATISFACTORY.

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Wall stem check - back reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-2.00	113.87	0.55	1.000	1.000	1.000
Earthq.- constr.	7.69	-2.00	-3.85	0.55	1.000	1.000	1.000
Pressure at rest	45.26	-1.32	9.05	1.14	1.000	1.000	1.000
Water pressure	0.00	-4.13	0.00	1.00	1.000	1.000	1.000
Earthquake - pressure at rest	22.24	-2.06	0.00	1.00	1.000	1.000	1.000
Voz1	21.49	-2.01	4.30	1.11	0.700	0.700	0.700
Tucanik	9.62	-2.02	1.92	1.11	1.000	1.000	1.000

Wall stem check - back reinf.

Wall check at the construction joint 4.13 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1550.0 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.21 m

Reinforcement ratio	ρ	=	0.18 %	>	0.14 %	=	ρ_{min}
Position of neutral axis	x	=	0.07 m	<	0.71 m	=	x_{max}
Ultimate shear force	V_{Rd}	=	338.65 kN	>	99.85 kN	=	V_{Ed}
Ultimate moment	M_{Rd}	=	1015.02 kNm	>	168.71 kNm	=	M_{Ed}

Cross-section is SATISFACTORY.

Wall jump check

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-1.72	323.78	2.61	1.000
Earthq.- constr.	21.86	-1.72	-10.94	2.61	1.000
Weight - earth wedge	0.00	-3.62	233.61	4.21	1.000
Earthquake - soil wedge	15.77	-3.62	-7.90	4.21	1.000
Active pressure	216.85	-2.19	90.19	5.60	1.000
Water pressure	0.00	-5.63	0.00	5.60	1.000
Earthq.- act.pressure	135.17	-4.06	75.24	5.60	1.000
Voz1	38.14	-2.20	16.75	5.60	0.700
Tucanik	15.21	-2.57	6.95	5.60	1.000

Wall jump check

Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1946.9 mm^2

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Cross-section width = 1.00 m
Cross-section height = 1.50 m

Reinforcement ratio	ρ	=	0.15	%	>	0.14	%	=	ρ_{min}
Position of neutral axis	x	=	0.08	m	<	0.89	m	=	x_{max}
Ultimate shear force	V_{Rd}	=	405.28	kN	>	255.98	kN	=	V_{Ed}
Ultimate moment	M_{Rd}	=	1282.63	kNm	>	229.97	kNm	=	M_{Ed}

Cross-section is SATISFACTORY.

Wall heel check

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-0.75	100.88	4.25	1.000
Weight - earth wedge	0.00	-3.62	233.61	4.21	1.000
Active pressure	216.85	-2.19	90.19	5.60	1.000
Voz1	38.14	-2.20	16.75	5.60	0.700
Tucanik	15.21	-2.57	6.95	5.60	1.000
Contact stress	0.00	0.00	-229.06	4.04	1.000

Wall heel check

Reinforcement and dimensions of the cross-section
6.67 prof. 20.0 mm, cover 50.0 mm
Inputted reinforcement area = 2095.4 mm^2
Required reinforcement area = 1946.9 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.50 m

Reinforcement ratio	ρ	=	0.15	%	>	0.14	%	=	ρ_{min}
Position of neutral axis	x	=	0.08	m	<	0.89	m	=	x_{max}
Ultimate shear force	V_{Rd}	=	405.28	kN	>	214.29	kN	=	V_{Ed}
Ultimate moment	M_{Rd}	=	1282.63	kNm	>	474.88	kNm	=	M_{Ed}

Cross-section is SATISFACTORY.

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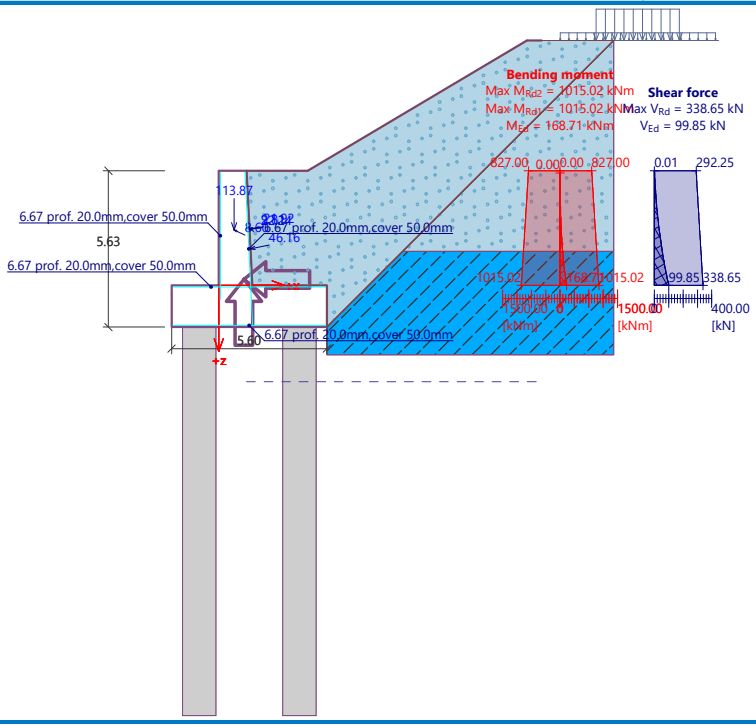
Name : Dimensioning	Stage - analysis : 2 - 1



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Потпорни зидови уз галерију на km 78+377 пруге

Кампада 7

Retaining Walls adjacent to the gallery at km 78+377 of the railway line

Section 7

Cantilever wall analysis

Input data

Project

Task : Пројекат потпорних конструкција
Part : Деоница: Нови Сад - Суботица - Државна граница (Келебија)
Description : Потпорни зид на км 78+377 пруге - Кампада 7
Date : 14.4.2021.

Settings

Standard - EN 1997 - PP2 - SRB

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : user-defined
Article 3.1.6 : $\alpha_{cc} = 0.85$

Wall analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Caquot-Kerisel
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Consider always vertical
Base key : The base key is considered as inclined footing bottom
Allowable eccentricity : 0.170
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

Partial factors on actions (A)					
Permanent design situation					
		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.35	[–]	1.00	[–]
Variable actions :	γ_Q =	1.50	[–]	0.00	[–]
Water load :	γ_w =	1.35	[–]		

Partial factors for resistances (R)			
Permanent design situation			
Partial factor on overturning :	γ_{Rv} =	1.40	[–]
Partial factor on sliding resistance :	γ_{Rh} =	1.10	[–]
Partial factor on bearing capacity :	γ_{Re} =	1.40	[–]

Partial factors for variable actions			
Permanent design situation			
Factor for combination value :	ψ_0 =	0.70	[–]
Factor for frequent value :	ψ_1 =	0.50	[–]
Factor for quasi-permanent value :	ψ_2 =	0.30	[–]

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Partial factors on actions (A)					
Seismic design situation					
		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.00	[–]	1.00	[–]
Variable actions :	γ_Q =	1.00	[–]	0.00	[–]
Water load :	γ_w =	1.00	[–]		

Partial factors for resistances (R)			
Seismic design situation			
Partial factor on overturning :	γ_{Rv} =	1.40	[–]
Partial factor on sliding resistance :	γ_{Rh} =	1.25	[–]
Partial factor on bearing capacity :	γ_{Re} =	1.40	[–]

Material of structure

Unit weight γ = 25.00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete: C 25/30
Cylinder compressive strength f_{ck} = 25.00 MPa
Tensile strength f_{ctm} = 2.60 MPa

Longitudinal steel: B500B
Yield strength f_{yk} = 500.00 MPa

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0.00	0.00
2	0.00	3.03
3	2.90	3.03
4	2.90	4.03
5	2.90	5.03
6	1.90	5.03
7	1.90	4.03
8	-1.30	4.03
9	-1.30	3.03
10	-1.00	3.03
11	-1.00	0.00

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 8.23 m^2.

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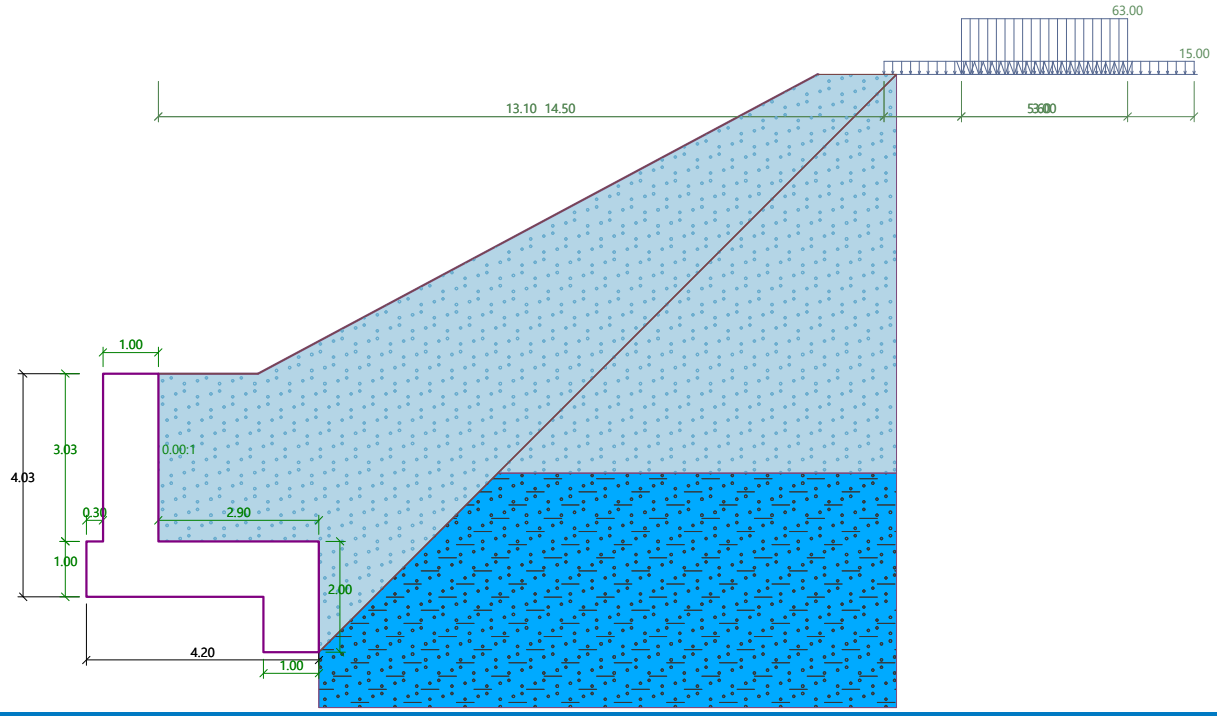
Name : Geometry	Stage - analysis : 1 - 0



Basic soil parameters

No.	Name	Pattern	ϕ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
1	Zasip		30.00	0.00	20.00	10.00	10.00
2	siSa		26.00	12.00	20.30	10.30	8.00
3	SaP		30.00	5.00	20.10	10.10	10.00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	ϕ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
1	Zasip		cohesive	-	0.20	-	-
2	siSa		cohesive	-	0.30	-	-
3	SaP		cohesive	-	0.28	-	-

Soil parameters

Zasip

Unit weight :	γ = 20.00 kN/m^3
Stress-state :	effective
Angle of internal friction :	ϕ_{ef} = 30.00 °
Cohesion of soil :	c_{ef} = 0.00 kPa
Angle of friction struc.-soil :	δ = 10.00 °
Soil :	cohesive
Poisson's ratio :	ν = 0.20

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Saturated unit weight : γ_{sat} = 20.00 kN/m^3

siSa

Unit weight : γ = 20.30 kN/m^3
Stress-state : effective
Angle of internal friction : ϕ_{ef} = 26.00 °
Cohesion of soil : c_{ef} = 12.00 kPa
Angle of friction struc.-soil : δ = 8.00 °
Soil : cohesive
Poisson's ratio : ν = 0.30
Saturated unit weight : γ_{sat} = 20.30 kN/m^3

SaP

Unit weight : γ = 20.10 kN/m^3
Stress-state : effective
Angle of internal friction : ϕ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 5.00 kPa
Angle of friction struc.-soil : δ = 10.00 °
Soil : cohesive
Poisson's ratio : ν = 0.28
Saturated unit weight : γ_{sat} = 20.10 kN/m^3

Backfill

Assigned soil : Zasip
Slope = 45.00 °

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	1.80	0.00 .. 1.80	Zasip	
2	7.60	1.80 .. 9.40	siSa	
3	-	9.40 .. ∞	siSa	

Foundation

Type of foundation : input parameters of contact base-soil

Parameters

Angle of friction base-soil ψ = 26.00 °
Cohesion base-soil a = 0.00 kPa

Terrain profile

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	1.80	0.00
3	11.90	-5.40
4	12.90	-5.40

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Origin [0,0] is located in upper right edge of construction.
Positive coordinate +z has downward direction.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
	new	change						
1	Yes		variable	63.00		14.50	3.00	on terrain
2	Yes		permanent	15.00		13.10	5.60	on terrain

No.	Name
1	Voz1
2	Tucanik

Resistance on front face of the structure

Resistance on front face of the structure is not considered.

Settings of the stage of construction

Design situation : permanent
The wall is free to move. Active earth pressure is therefore assumed.

Verification No. 1 (Stage of construction 1)

Active pressure behind the structure - partial results

Layer No.	Thickness [m]	α [°]	ϕ_d [°]	c_d [kPa]	γ [kN/m³]	δ_d [°]	K_a	Comment
1	0.59	0.00	30.00	0.00	20.00	30.00	0.609	
2	1.80	0.00	30.00	0.00	20.00	30.00	0.609	
3	1.23	0.00	30.00	0.00	20.00	30.00	0.609	
4	1.00	0.00	30.00	0.00	20.00	10.00	0.571	
5	1.00	0.00	30.00	0.00	20.00	10.00	0.571	

Active pressure distribution behind the structure (without surcharge)

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.59	0.00	0.00	0.00	0.00	0.00
	0.00	11.76	0.00	7.17	6.21	3.58
2	0.00	11.76	0.00	7.17	6.21	3.58
	1.80	47.76	0.00	29.10	25.20	14.55
3	1.80	47.76	0.00	29.10	25.20	14.55
	3.03	72.36	0.00	44.08	38.18	22.04
4	3.03	72.36	0.00	41.29	40.66	7.17
	4.03	92.36	0.00	52.70	51.90	9.15
5	4.03	92.36	0.00	52.70	51.90	9.15
	5.03	112.36	0.00	64.11	63.13	11.13

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Pressure distribution from surcharge - Voz1

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.59	0.00	0.00
2	0.00	0.00	0.00
3	0.00	0.00	0.00
4	1.80	0.00	0.00
5	1.89	0.00	0.00
6	1.89	8.91	5.14
7	3.03	8.25	4.76
8	3.03	9.74	1.72
9	4.03	9.14	1.61
10	5.03	8.54	1.51

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-1.12	205.75	1.82	1.000	1.000	1.350
Weight - earth wedge	0.00	-2.58	182.21	2.79	1.000	1.000	1.350
Active pressure	172.85	-0.84	58.17	4.20	1.350	1.350	1.350
Voz1	28.10	-0.57	8.89	4.20	0.000	1.500	1.500
Tucanik	11.97	-0.96	4.40	4.20	1.350	1.350	1.350

Verification of complete wall

Check for overturning stability

Resisting moment M_{res} = 883.22 kNm/m

Overturning moment M_{ovr} = 211.09 kNm/m

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 239.49 kN/m

Active horizontal force H_{act} = 171.22 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 165.38 kPa

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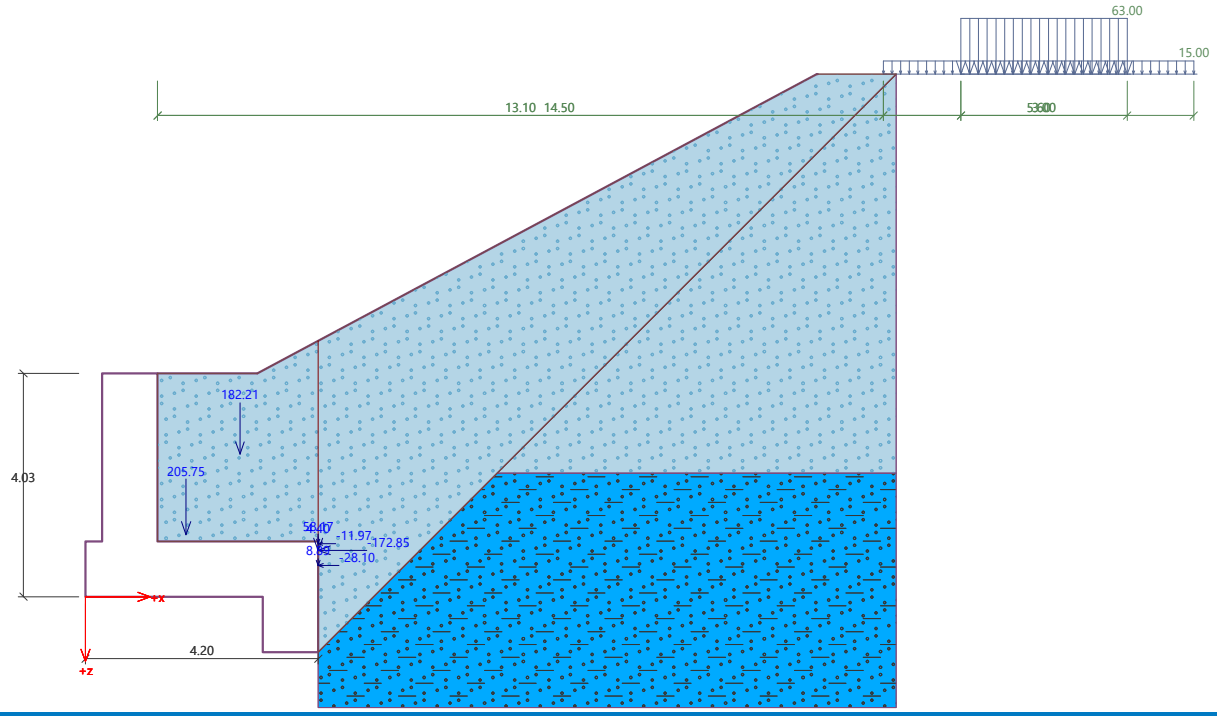
Name : Verification	Stage - analysis : 1 - 1



Bearing capacity of foundation soil (Stage of construction 1)

Design load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [–]	Stress [kPa]
1	84.95	672.22	128.03	0.030	165.38
2	91.46	527.15	161.63	0.042	130.53

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	61.67	496.26	92.19
2	50.39	487.60	94.20

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force $e = 0.042$
Maximum allowable eccentricity $e_{alw} = 0.170$

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Bearing capacity of foundation soil $R = 250.00$ kPa
Partial factor on bearing capacity $\gamma_{Rv} = 1.40$
Max. stress at footing bottom $\sigma = 165.38$ kPa
Bearing capacity of foundation soil $R_d = 178.57$ kPa

Bearing capacity of foundation soil is SATISFACTORY

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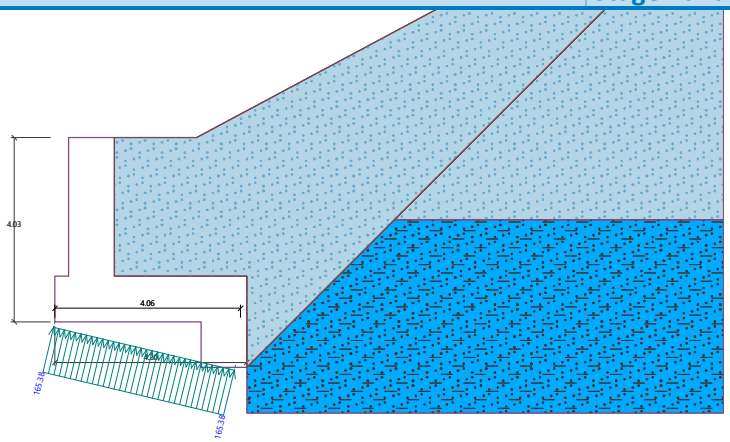
Overall verification - bearing capacity of found. soil is SATISFACTORY

Name : Bearing cap.	Stage - analysis : 1 - -1



Dimensioning No. 1 (Stage of construction 1)

Wall stem check - front reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-1.51	75.72	0.50	1.000	1.350	1.000
Pressure at rest	23.20	-1.00	0.00	1.00	1.350	1.000	1.350
Voz1	13.88	-1.47	0.00	1.00	1.500	0.000	1.500
Tucanik	6.27	-1.48	0.00	1.00	1.350	1.000	1.350

Wall stem check - front reinf.

Front reinforcement is not required.

Wall stem check - back reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-1.51	75.72	0.50	1.000	1.350	1.000
Pressure at rest	23.20	-1.00	0.00	1.00	1.350	1.000	1.350
Voz1	13.88	-1.47	0.00	1.00	1.500	0.000	1.500
Tucanik	6.27	-1.48	0.00	1.00	1.350	1.000	1.350

Wall stem check - back reinf.

Wall check at the construction joint 3.03 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 16.0 mm, cover 50.0 mm
Inputted reinforcement area = 1341.1 mm^2
Required reinforcement area = 1273.6 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.00 m

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Reinforcement ratio	ρ	=	0.14	%	>	0.14	%	= ρ_{min}
Position of neutral axis	x	=	0.05	m	<	0.58	m	= x_{max}
Ultimate shear force	V_{Rd}	=	291.05	kN	>	60.60	kN	= V_{Ed}
Ultimate moment	M_{Rd}	=	537.76	kNm	>	74.47	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

Wall heel check

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-0.50	72.50	2.75	1.350
Weight - earth wedge	0.00	-2.58	182.21	2.79	1.350
Active pressure	172.85	-0.84	58.17	4.20	1.350
Voz1	28.10	-0.57	8.89	4.20	1.500
Tucanik	11.97	-0.96	4.40	4.20	1.350
Contact stress	0.00	0.00	-438.21	2.69	1.000

Wall heel check

Reinforcement and dimensions of the cross-section
6.67 prof. 16.0 mm, cover 50.0 mm

Inputted reinforcement area		=	1341.1	mm^2				
Required reinforcement area		=	1273.6	mm^2				
Cross-section width		=	1.00	m				
Cross-section height		=	1.00	m				
Reinforcement ratio	ρ	=	0.14	%	>	0.14	%	= ρ_{min}
Position of neutral axis	x	=	0.05	m	<	0.58	m	= x_{max}
Ultimate shear force	V_{Rd}	=	291.05	kN	>	3.46	kN	= V_{Ed}
Ultimate moment	M_{Rd}	=	537.26	kNm	>	184.29	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

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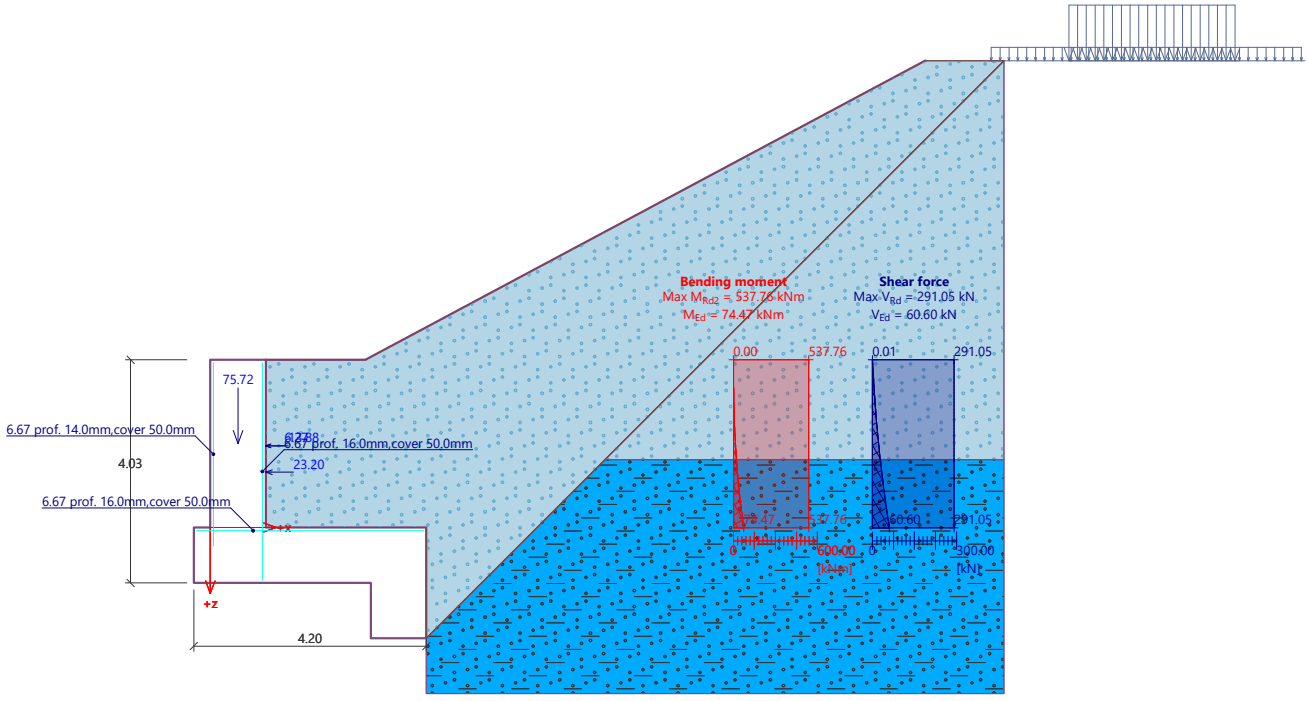
Name : Dimensioning	Stage - analysis : 1 - 1



Input data (Stage of construction 2)

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	1.80	0.00 .. 1.80	Zasip	
2	7.60	1.80 .. 9.40	siSa	
3	-	9.40 .. ∞	siSa	

Foundation

Type of foundation : input parameters of contact base-soil

Parameters

Angle of friction base-soil ψ = 26.00 °

Cohesion base-soil a = 0.00 kPa

Terrain profile

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	1.80	0.00
3	11.90	-5.40
4	12.90	-5.40

Origin [0,0] is located in upper right edge of construction.

Positive coordinate +z has downward direction.

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Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
	new	change						
1	No	No	variable	63.00		14.50	3.00	on terrain
2	No	No	permanent	15.00		13.10	5.60	on terrain

No.	Name
1	Voz1
2	Tucanik

Resistance on front face of the structure

Resistance on front face of the structure: at rest
Soil on front face of the structure - Zasip
Soil thickness in front of structure h = 1.00 m

Terrain in front of structure is flat.

Earthquake

Factor of horizontal acceleration K_h = 0.0675
Factor of vertical acceleration K_v = 0.0338

Water below the GWT is restricted.

Settings of the stage of construction

Design situation : seismic
The wall is free to move. Active earth pressure is therefore assumed.

Verification No. 1 (Stage of construction 2)

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-1.12	205.75	1.82	1.000	1.000	1.000
Earthq.- constr.	13.89	-1.12	-6.95	1.82	1.000	1.000	1.000
FF resistance	-2.50	-0.33	0.00	0.00	1.000	1.000	1.000
Weight - earth wedge	0.00	-2.58	182.21	2.79	1.000	1.000	1.000
Earthquake - soil wedge	12.30	-2.58	-6.16	2.79	1.000	1.000	1.000
Active pressure	172.85	-0.84	58.17	4.20	1.000	1.000	1.000
Earthq.- act.pressure	115.49	-2.80	61.69	4.20	1.000	1.000	1.000
Voz1	28.10	-0.57	8.89	4.20	0.000	0.700	0.700
Tucanik	11.97	-0.96	4.40	4.20	1.000	1.000	1.000

Verification of complete wall

Check for overturning stability

Resisting moment M_{res} = 981.29 kNm/m
Overturning moment M_{ovr} = 525.89 kNm/m

Wall for overturning is SATISFACTORY

Check for slip

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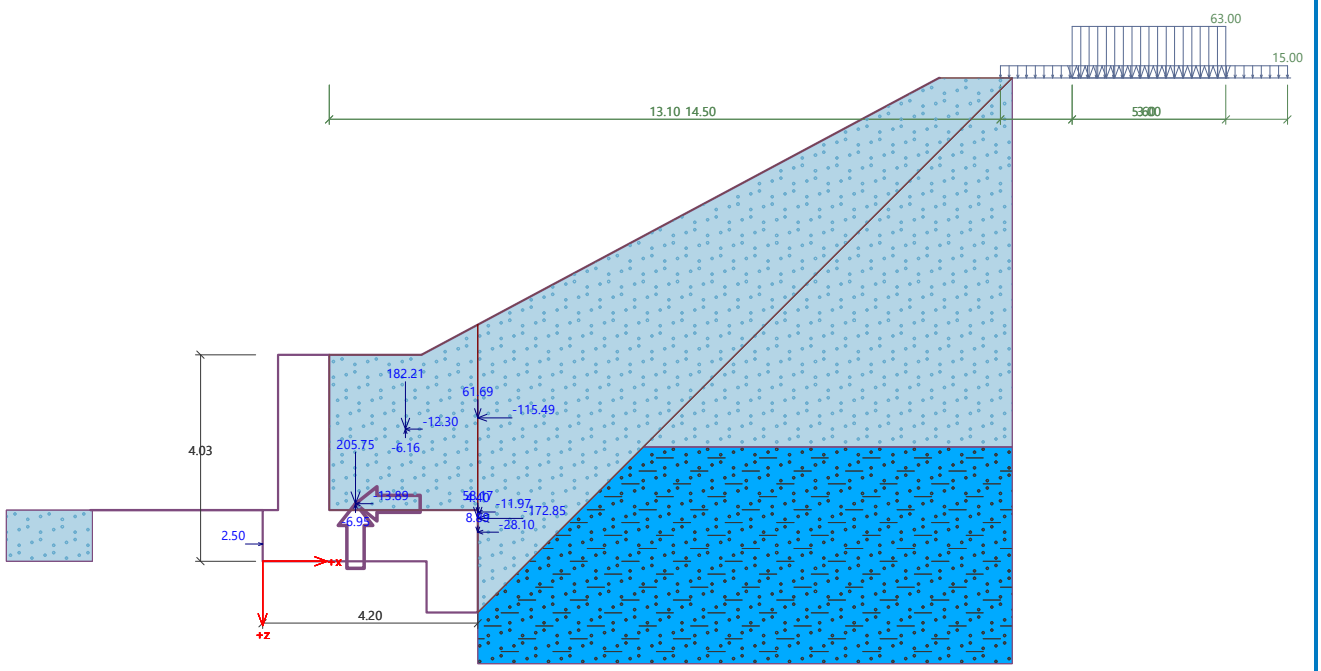
Resisting horizontal force H_{res} = 222.87 kN/m
Active horizontal force H_{act} = 217.28 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 189.05 kPa

Name : Verification	Stage - analysis : 2 - 1



Warning - allowable range of input data exceeded during earthquake analysis!
The analysis is carried out with the modified value of terrain inclination β. (β=28.13°, β_{modif}=26.00°)

Bearing capacity of foundation soil (Stage of construction 2)

Design load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [–]	Stress [kPa]
1	370.13	571.20	202.03	0.154	189.05
2	362.22	565.14	203.43	0.154	185.31

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	373.51	575.75	209.18
2	362.22	567.10	211.18

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force e = 0.154
Maximum allowable eccentricity e_{alw} = 0.170

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Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Bearing capacity of foundation soil $R = 400.00$ kPa
Partial factor on bearing capacity $\gamma_{Rv} = 1.40$
Max. stress at footing bottom $\sigma = 189.05$ kPa
Bearing capacity of foundation soil $R_d = 285.71$ kPa

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Dimensioning No. 1 (Stage of construction 2)

Wall stem check - front reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-1.51	75.72	0.50	1.000	1.000	1.000
Earthq.- constr.	5.11	-1.51	-2.56	0.50	1.000	1.000	1.000
Pressure at rest	23.20	-1.00	0.00	1.00	1.000	1.000	1.000
Earthquake - pressure at rest	11.97	-1.51	0.00	1.00	1.000	1.000	1.000
Voz1	13.88	-1.47	0.00	1.00	0.700	0.000	0.700
Tucanik	6.27	-1.48	0.00	1.00	1.000	1.000	1.000

Wall stem check - front reinf.

Front reinforcement is not required.

Wall stem check - back reinf.

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-1.51	75.72	0.50	1.000	1.000	1.000
Earthq.- constr.	5.11	-1.51	-2.56	0.50	1.000	1.000	1.000
Pressure at rest	23.20	-1.00	0.00	1.00	1.000	1.000	1.000
Earthquake - pressure at rest	11.97	-1.51	0.00	1.00	1.000	1.000	1.000
Voz1	13.88	-1.47	0.00	1.00	0.700	0.000	0.700
Tucanik	6.27	-1.48	0.00	1.00	1.000	1.000	1.000

Wall stem check - back reinf.

Wall check at the construction joint 3.03 m from the wall crest
Reinforcement and dimensions of the cross-section
6.67 prof. 16.0 mm, cover 50.0 mm
Inputted reinforcement area = 1341.1 mm^2
Required reinforcement area = 1273.6 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.00 m

Reinforcement ratio $\rho = 0.14\ \% > 0.14\ \% = \rho_{min}$
Position of neutral axis $x = 0.05\ m < 0.58\ m = x_{max}$
Ultimate shear force $V_{Rd} = 291.05\ kN > 56.26\ kN = V_{Ed}$

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Ultimate moment M_{Rd} = 537.76 kNm > 72.62 kNm = M_{Ed}

Cross-section is SATISFACTORY.

Wall heel check

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-0.50	72.50	2.75	1.000
Weight - earth wedge	0.00	-2.58	182.21	2.79	1.000
Active pressure	172.85	-0.84	58.17	4.20	1.000
Voz1	28.10	-0.57	8.89	4.20	0.700
Tucanik	11.97	-0.96	4.40	4.20	1.000
Contact stress	0.00	0.00	-281.40	2.32	1.000

Wall heel check

Reinforcement and dimensions of the cross-section
6.67 prof. 16.0 mm, cover 50.0 mm
Inputted reinforcement area = 1341.1 mm^2
Required reinforcement area = 1273.6 mm^2
Cross-section width = 1.00 m
Cross-section height = 1.00 m

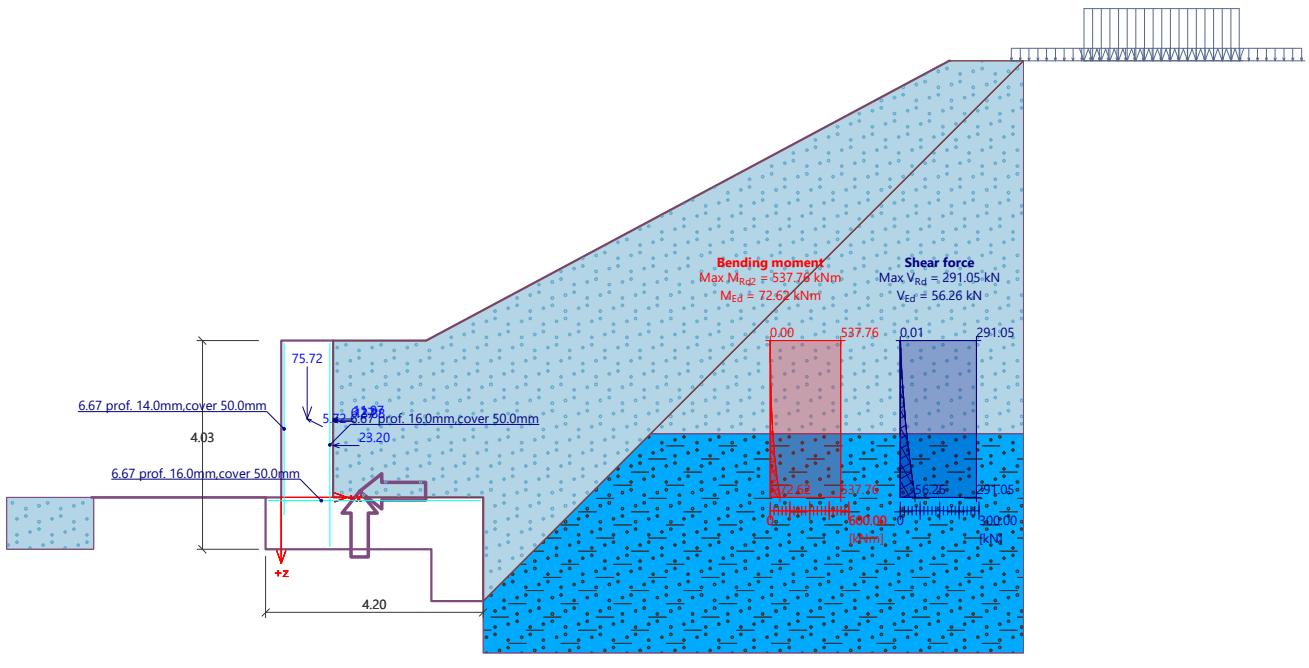
Reinforcement ratio	ρ	=	0.14	%	>	0.14	%	= $ρ_{min}$
Position of neutral axis	x	=	0.05	m	<	0.58	m	= x_{max}
Ultimate shear force	V_{Rd}	=	291.05	kN	>	42.12	kN	= V_{Ed}
Ultimate moment	M_{Rd}	=	537.26	kNm	>	289.69	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

Одгооврни пројектант :
Зоран Луковић,
дипл.грађ.инж.
лиценна бр. 310 3032 03

Зоран Луковић

Name : Dimensioning	Stage - analysis : 2 - 1



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2/1.1.3.2.6.3 ПРЕДМЕР И ПРЕДРАЧУН РАДОВА

ПРОЈЕКАТ ЗА ГРАЂЕВИНСКУ ДОЗВОЛУ
Пруга Београд - Суботица - државна граница (Келебија), ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
2/1 ПРОЈЕКАТ КОНСТРУКЦИЈА
2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03
Потпорне конструкције

DESIGN FOR BUILDING PERMIT
Railway line Belgrade - Subotica - State border (Kelebia), SECTION NOVI SAD - SUBOTICA - STATE BORDER (KELEBIJA)
2/1 DESIGN OF CONSTRUCTIONS
2/1.1.3.2 Retaining walls adjacent to the gallery at km 78+377.03
Retaining structures

Бр. поз. No.	Бр.поз. Техн Усл Item in Tech. Conditions	Опис радова	Description	Јед. мере Unit	Количина Quantity	Јед. цена (дин) Unit rate (Din)	Цена (дин) Price (Din)
					A	B	A´B
2/1.1.3.2.1	**02**	**ИЗВОЂЕЊЕ HW ШИПОВА**	**HW PILES**				
2/1.1.3.2.1.1		Извођење HW бушених шипова од бетона C 30/37 У цену радова је укључен сав рад на извођењу, а плаћа се готов шип по m'. Арматура се плаћа посебно. Ø120 cm	Construct HW bored pipes of concrete C 30/37. The price covers all construction work and payment shall be made per each finished pipe, per linear meter. Reinforcement to be paid separately. Ø120cm	m'	880.00	50,000.00	44,000,000.00
2/1.1.3.2.1.2		Израда, уградња и монтажа арматуре HW шипова. Плаћа се по kg уграђене арматуре. B 500B	Prepare, position and tie rebars in HW piles. Payment per kg of placed rebars. B 500B	kg	477,480.96	120.00	57,297,715.20
2/1.1.3.2.1.3		Пробно оптерећење шипова, испитивање носивости шипова.	Carry out trial loading of piles to test pile capacity Lump sum payment.	паушално / lump sum			0.00
		УКУПНО ИЗВОЂЕЊЕ HW ШИПОВА:	**TOTAL FOR HW PILES:**				**101,297,715.20**
2/1.1.3.2.2	**03**	**ЗЕМЉАНИ РАДОВИ**	**EARTHWORKS**				
2/1.1.3.2.2.1		Ископ темеља у материјалу I и II категорије, са свом потебном подградом и транспортом ископаног материјала до 5 km. Плаћа се по m^3 ископаног материјала - на дубини 0-2 m - на дубини 2-4 m - на дубини 4-6 m	Excavate foundations in soil cat. I & II, place necessary timbering and haul excavated earth to 5 km distance. Payment per m^3 of excavated material - 0-2 m by depth - 2-4 m by depth - 4-6 m by depth	 m^3 m^3 m^3	 1,550.21 0.00 0.00	 890.00 1,200.00 1,350.00	 1,379,685.12 0.00 0.00
2/1.1.3.2.2.2		Насипање материјала / затрпавање темеља стубова, из ископа или позајмишта, у слојевима по 30 cm, земљаним материјалом, са набијањем слојева до модула стшљивости Ms=30MPa. Плаћа се по m^3 набијеног материјала	Backfill pier foundations using earth from borrow pit, in 30 cm layers tamped to modulus of compresibility of Ms=30MPa. Payment per m^3 of tamped earth	m^3	1,391.66	1,800.00	2,504,995.20

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2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03
Потпорне конструкције

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2/1.1.3.2 Retaining walls adjacent to the gallery at km 78+377.03
Retaining structures

Бр. поз. No.	Бр.поз. Техн Усл Item in Tech. Conditions	Опис радова	Description	Јед. мере Unit	Количина Quantity	Јед. цена (дин) Unit rate (Din)	Цена (дин) Price (Din)
					A	B	A´B
2/1.1.3.2.2.3		Израда испуне од крупнозрног материјала, са набијањем у слојевима, дебљине d=30cm, до вредности збијања Dpr≥1. Испуна се уграђује у слојевима дебљине по d=30cm, минимум 1m дебљине. Плаћа се по m^3 набијеног материјала.	Bild filling of well grained gravel tamped in 30cm layers o comaction value of Dpr≥1. The filling is bild in 30cm layers , in total minimum 1m thick. It is paid per m3 of compacted material.	m^3	5,103.36	2,000.00	10,206,710.40
2/1.1.3.2.2.4		Израда кегли, према пројекту, материјалом добијеним из усека или позајмишта са механичким набијањем у слојевима од по 30cm.	Build newly designed backwalls of earth recovered from cuttings or borrow pits and tamp them mechanically, 30 cm layers.	m^3	0.00	2,900.00	0.00
УКУПНО ЗЕМЉАНИ РАДОВИ:			**TOTAL EARTH WORKS:**				**14,091,390.72**

2/1.1.3.2.3	**04**	**БЕТОНСКИ И АРМИРАНОБЕТОНСКИ РАДОВИ**	**PLAIN AND REINFORCED CONCRETE**				
		Све позиције обухватају поред описа појединачних ставки и следеће заједничке услове : - Бетонски радови ће бити изведени у свему по пројекту, статичком прорачуну и важећим правилницима. Цене садрже све радне операције, утрошке материјала, помоћни алат, оплате и скеле које прописују "Нормативи и стандарди рада у грађевинарству-Високоградња ГН 400", као и остале трошкове и зараду предузећа. - Бетон ће бити справљен, транспортован, уграђен, негован и испитиван на пробним узорцима по одредбама које прописује важећи "Правилник о техничким нормативима за бетон и армирани бетон" (ПБАБ 87-"Службени лист СФРЈ" бр.11/87). - Бетон ће бити справљен од агрегата и цемента атестираних по важећим српским стандардима. - Бетон класе B.II мора имати све класе отпорности дефинисане појединачним позицијама. - Обрачун количина стварно изведених радова извршиће се према одредбама које прописују "Нормативи и стандарди рада у грађевинарству". -Мешање бетона мора се вршити машинским путем, а набијање вибрирањем -Арматура се плаћа посебно -Каблови се плаћају посебно -У цену бетона је урачуната оплата и скела -Плаћа се за потпуно готов посао од m³ уграђеног бетона				
	04.01	**Неармирани бетон**	**Plain concrete**				
2/1.1.3.2.3.1		Мршави бетон - изравњавајући слој, дебљине 10 cm, C12/15, испод темеља стубова, крилних зидова, темељних плоча, наглавних греда, прелазних плоча од бетона.	Cast lean concrete C12/15 for 10 cm thick blinding layers under pier foundations, wing walls, foundation slabs, pile caps, transition slabs.	m^3	45.80	12,000.00	549,619.20

ПРОЈЕКАТ ЗА ГРАЂЕВИНСКУ ДОЗВОЛУ
Пруга Београд - Суботица - државна граница (Келебија), ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
2/1 ПРОЈЕКАТ КОНСТРУКЦИЈА
2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03
Потпорне конструкције

DESIGN FOR BUILDING PERMIT
Railway line Belgrade - Subotica - State border (Kelebia), SECTION NOVI SAD - SUBOTICA - STATE BORDER (KELEBIJA)
2/1 DESIGN OF CONSTRUCTIONS
2/1.1.3.2 Retaining walls adjacent to the gallery at km 78+377.03
Retaining structures

Бр. поз. No.	Бр.поз. Техн Усл Item in Tech. Conditions	Опис радова	Description	Јед. мере Unit	Количина Quantity	Јед. цена (дин) Unit rate (Din)	Цена (дин) Price (Din)
					A	B	A´B
	04.02	**Армирано бетонске темељне конструкције**	**Reinforced concrete foundations**				
2/1.1.3.2.3.2		Армирани бетон темеља стубова и темеља крилних зидова, тракастих темеља, контра-греда, плочастих темеља, јастука, наглавних греда и бунара. Бетон класе : C 30/37	Cast reinforced concrete in pier and wingwall foundations, strip foundations, counter beams, foundation mats, cushions, pile caps and wells. Concrete class: C 30/37	m^3	651.79	21,600.00	14,078,707.20
	04.03	**Стубови као ослонци распонских конструкција разних система и лежишне греде**	**Supporting piers under spanning construction of various systems and bearing beams**				
2/1.1.3.2.3.3		Тело стубова галерије од бетона класе C 40/50, XC4, VI	Cast bodies of gallery piers, concrete class C 40/50, XC4, VI	m^3	58.68	27,600.00	1,619,576.83
2/1.1.3.2.3.4		Зидови галерије од бетона класе C 30/37, XC4, VI	Gallery walls of concrete class C 30/37, XC4, VI	m^3	549.03	27,600.00	15,153,283.20
2/1.1.3.2.3.5		Лежишне греде стубова од бетона класе C 30/37, XC4,VI	Cast bearing beams on piers of concrete class C 30/37, XC4,VI	m^3	122.43	30,600.00	3,746,235.60
	04.04	**Распонска конструкција моста од армираног бетона**	**Bridge constructions in spans of reinforced concrete**				
2/1.1.3.2.3.6		Армиранобетонски попречни носачи за везу стубова и зидова. Бетон класе C 30/37, XC4, XD1, XF2, V-II	Cast reinforced concrete cross girders connecting walls and piers. Concrete class C 30/37, XC4, XD1, XF2, V-II	m^3	96.00	30,600.00	2,937,600.00
2/1.1.3.2.3.7		Ивични венци пешачких стаза ливени на лицу места, (укључујући и ревизионе шахтове) од бетона класе C 40/50, XC4,, XF4, VIII, MS-S2.	Cast in situ footway cornices (with inspection chambers) of concrete class C 40/50, XC4, XF4, VIII, MS-S2.	m^3	0.00	37,200.00	0.00

УКУПНО БЕТОНСКИ РАДОВИ: TOTAL FOR CONCRETING:	**38,085,022.03**

ПРОЈЕКАТ ЗА ГРАЂЕВИНСКУ ДОЗВОЛУ
Пруга Београд - Суботица - државна граница (Келебија), ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
2/1 ПРОЈЕКАТ КОНСТРУКЦИЈА
2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03
Потпорне конструкције

DESIGN FOR BUILDING PERMIT
Railway line Belgrade - Subotica - State border (Kelebia), SECTION NOVI SAD - SUBOTICA - STATE BORDER (KELEBIJA)
2/1 DESIGN OF CONSTRUCTIONS
2/1.1.3.2 Retaining walls adjacent to the gallery at km 78+377.03
Retaining structures

Бр. поз. No.	Бр.поз. Техн Усл Item in Tech. Conditions	Опис радова	Description	Јед. мере Unit	Количина Quantity	Јед. цена (дин) Unit rate (Din)	Цена (дин) Price (Din)
					A	B	A´B
2/1.1.3.2.4	**05**	**РАДОВИ ОД МЕТАЛА**	**METALWORK**				
		Све позиције обухватају поред описа појединачних ставки и следеће заједничке услове: - Армирачки радови ће бити изведени у свему по пројекту, статичком прорачуну и важећим правилницима. Цене садрже све радне операције, утрошке материјала, помоћни алат и скеле које прописују "Нормативи и стандарди рада у грађевинарству-Високоградња ГН 400", као и остале трошкове и зараду предузећа. - Арматуру очистити од рђе и прљавштине, исправити, исећи, савити и уградити по детаљима (арамтурним нацртима) и статичком прорачуну. - За квалитет уграђене арматуре одговара извођач радова. - Јединична цена садржи и постављање подметача од челика,пластике или бетона за постизање предвиђених заштитних слојева и правилног положаја арматуре у конструкцији. Сва подеона гвожђа и узенгије ће бити чврсто везани за главну арматуру тако да не може доћи до промене положаја арматуре за време бетонирања конструкције. - Стварно уграђена количина арматуре свих квалитета обрачунава се по kg без обзира на сложеност и пречнике шипки арматуре. - Обрачун количина извршити према табличним тежинама арматуре и ужади и дужинама из арматурних нацрта.				
2/1.1.3.2.4.1		Набавка, чишћење, сечење, машинско савијање и монтажа арматуре према пропису, пројекту и статичким детаљима. Плаћа се по kg уграђене арматуре. Ребраста арматура B 500B	Purchase, wire brush, cut, bend mechanically and position bars according to the regulation, the design and the static detailed drawings. Payment per kg of positioned bars. Ribbed reinforcement B 500B	kg	164,156.21	120.00	19,698,744.96
		Арматурна мрежа	Ribbed reinforcement - mesh B 500B	kg	0.00	120.00	0.00
		УКУПНО АРМИРАЧКИ РАДОВИ:	**TOTAL METALWORK:**				**19,698,744.96**
2/1.1.3.2.5	**06**	**ИЗОЛАТЕРСКИ РАДОВИ**	**WATERPROOFING**				
		- Сви изолатерски радови морају бити изведени педантно и тачно према захтевима из пројекта, предрачуна радова и детаљима. - Употребљени материјали морају одговарати важећим стандардима и прописима, снабдевени атестима овлашћене установе, проверени у употреби, трајни колико и објекат или пројектовани тако да је њихова замена могућа. - Све грешке на конструкцији морају се на одговарајући начин отклонити или санирати пре почетка наношења изолационог материјала. - У јединичну цену је урачуната набавка свог потребног материјала, алата, транспорт и израда. - Плаћа се за потпуно готов посао по m^2 урађене изолације и/или заштите.					
2/1.1.3.2.5.1		Израда хидроизолације горње плоче и конзола на бази метил метакрилата, прскањем под притиском. Радови по овој позицији се изводе у складу са техничким условима и нормативима за ову врсту послова као и по технологији произвођача. У цену су у рачунати набавка материјала, транспорт и уградња.	Spray under pressurea layer of waterproofing material based on methyl metacrilate on deck and cantilevers.Work against this item shall conform to the relevant technical conditions and standards, and the manufacturer's technology. The price includes purchase of materials, transport and application.	m^2	0.00	4,150.00	0.00

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2/1 ПРОЈЕКАТ КОНСТРУКЦИЈА
2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03
Потпорне конструкције

DESIGN FOR BUILDING PERMIT
Railway line Belgrade - Subotica - State border (Kelebia), SECTION NOVI SAD - SUBOTICA - STATE BORDER (KELEBIJA)
2/1 DESIGN OF CONSTRUCTIONS
2/1.1.3.2 Retaining walls adjacent to the gallery at km 78+377.03
Retaining structures

Бр. поз. No.	Бр.поз. Техн Усл Item in Tech. Conditions	Опис радова	Description	Јед. мере Unit	Количина Quantity	Јед. цена (дин) Unit rate (Din)	Цена (дин) Price (Din)
					A	B	A´B
2/1.1.3.2.5.2		Израда хидроизолације од једног хладног премаза битулитом и једног премаза врућим битуменом бетонских површина које су у контакту са земљом. У цену је урачуната и заштита површина према деловима насипа који се набијају.	Apply waterproofing of one cold coat of bitumen emulsion and one hot bitumen coat onto concrete surfaces in contact with ground. The price includes waterproofing protection for the parts of compact embankment.	m^2	1,277.16	1,200.00	1,532,592.00
2/1.1.3.2.5.3		Израда заштите бетонских површина заштитним хидрофобним премазом за бетон, на бази пенетрата. Површине морају бити претходно очишћене и суве. Премазивање подразумева заштиту и импрегнацију свих видљивих бетонских површина моста које су у додиру са атмосферским утицајима.	Protect concrete surfaces with protective hydrophobic penetrat-based coats. Surfaces shall be clean and dry prior to application. This means that all visible concrete surfaces on the bridge exposed to atmosphere shall be coated for the purpose of protection and impregnation.	m^2	1,686.72	2,000.00	3,373,440.00
2/1.1.3.2.5.4		Заштитни премаз бетона на пешачким стазама, степеницама и подестима, d=3-3.5 mm, формираног од 4 слоја: епокси прајмер, водоотпорни слој пур смоле, основни премаз пур смоле(полиуретан) са кварц песком (0.5-1 mm) и завршни слој пур смоле.	Apply protective coats onto concrete surface on footways, steps and landings, 3-3.5 mm thick, 4-ply of epoxy primer, water repellent pur resin, base coat of pur resin (polyurethane) with quartz sand (0.5-1 mm) and top coat of pur resin.	m^2	0.00	2,500.00	0.00

УКУПНО ИЗОЛАТЕРСКИ РАДОВИ:	**TOTAL WATERPROOFING:**	**4,906,032.00**

2/1.1.3.2.6	**08**	**ОСТАЛИ РАДОВИ**	**MISCELLANEOUS**				
		За све позиције наведених радова важи: * у цену је урачуната набавка свог потребног материјала, алата, механизације, транспорт, израда и монтажа према пројекту, а за комплетно завршен					
2/1.1.3.2.6.3		Израда и постављање ограде од челика S 235 JRG1. У цену је урачуната набавка материјала, израда, транспорт, монтажа, антикорозиона заштита са два основна и два завршна премаза покривном бојом, а у свему према пројекту. Плаћа се по kg постављене ограде. -цевне или од профила	Assemble and erect railing and fence of S 235 JRG1 steel. The price includes purchase of material, assembly transport, erection, anticorrosive protection of two primers and two top coats of paint, fully as designed. Payment per kg of railing/fence. - tubular railing or sections	kg	0.00	250.00	0.00
		- висока жичана заштитна ограда	- high protective fence of steel mesh	kg	0.00	250.00	0.00

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2/1 ПРОЈЕКАТ КОНСТРУКЦИЈА
2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03
Потпорне конструкције

DESIGN FOR BUILDING PERMIT
Railway line Belgrade - Subotica - State border (Kelebia), SECTION NOVI SAD - SUBOTICA - STATE BORDER (KELEBIJA)
2/1 DESIGN OF CONSTRUCTIONS
2/1.1.3.2 Retaining walls adjacent to the gallery at km 78+377.03
Retaining structures

Бр. поз. No.	Бр.поз. Техн Усл Item in Tech. Conditions	Опис радова	Description	Јед. мере Unit	Количина Quantity	Јед. цена (дин) Unit rate (Din)	Цена (дин) Price (Din)
					A	B	A´B
2/1.1.3.2.6.6		Израда и затварање спојница на бетону на местима споја дилатационих целина према детаљу из пројекта и спојева поклопаца на каналетама трајно еластичном масом. Плаћа се по m' уграђене спојнице.	Production and closing of joints on concrete at the joints of expansion joints according to the details from the project and joints of covers on the channels with permanently elastic mass. Payment per m' of finished joint.	m'	29.16	3,000.00	87,480.00
2/1.1.3.2.6.7		Набавка и постављање репера за мониторинг слегања	Procurement and positioning of benchmarks for settlement monitoring	ком. /pcs.	12.00	12,000.00	144,000.00
		УКУПНО ОСТАЛИ РАДОВИ:	**TOTAL MISCELLANEOUS:**				**231,480.00**

ЗБИРНА РЕКАПИТУЛАЦИЈА GRAND SUMMARY

2/1.1.3.2.1	02	ИЗВОЂЕЊЕ HW ШИПОВА	HW PILES	101,297,715.20
2/1.1.3.2.2	03	ЗЕМЉАНИ РАДОВИ	EARTHWORKS	14,091,390.72
2/1.1.3.2.3	04	БЕТОНСКИ И АРМИРАНОБЕТОНСКИ РАДОВИ	PLAIN AND REINFORCED CONCRETE	38,085,022.03
2/1.1.3.2.4	05	РАДОВИ ОД МЕТАЛА	METALWORK	19,698,744.96
2/1.1.3.2.5	06	ИЗОЛАТЕРСКИ РАДОВИ	WATERPROOFING	4,906,032.00
2/1.1.3.2.6	08	ОСТАЛИ РАДОВИ	MISCELLANEOUS	231,480.00

УКУПНО (дин): **GRAND TOTAL (Din):** **178,310,384.91**

Београд, април 2021. Belgrade, April 2021

Одговорни пројектант: Responsible designer:

Зоран Луковић, дипл.грађ.инж
лиценца бр.: 310 3032 03

Zoran Luković , grad.Civ.Eng.
Licence no.: 310 3032 03

ПРОЈЕКАТ ЗА ГРАЂЕВИНСКУ ДОЗВОЛУ

Пруга Београд - Суботица - државна граница (Келебија), ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)

2/1 ПРОЈЕКАТ КОНСТРУКЦИЈА

2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03
Потпорни зидови

DESIGN FOR BUILDING PERMIT

Railway line Belgrade - Subotica - State border (Kelebia), SECTION NOVI SAD - SUBOTICA - STATE BORDER (KELEBIJA)

2/1 DESIGN OF CONSTRUCTIONS

2/1.1.3.2 Retaining walls adjacent to the gallery at km 78+377.03
Retaining walls

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					A	B	A´B
2/1.1.3.2.1	**02**	**ИЗВОЂЕЊЕ HW ШИПОВА**	**HW PILES**				
2/1.1.3.2.1.1		Извођење HW бушених шипова од бетона C 25/30, XC2,PVII У цену радова је укључен сав рад на извођењу, а плаћа се готов шип по m'. Арматура се плаћа посебно. Ø120 cm	Construct HW bored pipes of concrete C 25/30, XC2, PVII. The price covers all construction work and payment shall be made per each finished pipe, per linear meter. Reinforcement to be paid separately. Ø120cm	m'	127.00	50,000.00	6,350,000.00
2/1.1.3.2.1.2		Израда, уградња и монтажа арматуре HW шипова. Плаћа се по kg уграђене арматуре. B 500B	Prepare, position and tie rebars in HW piles. Payment per kg of placed rebars. B 500B	kg	15,240.00	120.00	1,828,800.00
2/1.1.3.2.1.3		Пробно оптерећење шипова, испитивање носивости шипова.	Carry out trial loading of piles to test pile capacity Lump sum payment.	паушално / lump sum			245,364.00
		УКУПНО ИЗВОЂЕЊЕ HW ШИПОВА:	**TOTAL FOR HW PILES:**				**8,424,164.00**
2/1.1.3.2.2	**03**	**ЗЕМЉАНИ РАДОВИ**	**EARTHWORKS**				
		- Ископ и засип изнад дренаже улази у предмер за трасу денивелације. - Ископ и засип испод дренаже улази у предмер за потпорне зидове.					
2/1.1.3.2.2.1		Ископ темеља у материјалу I и II категорије, са свом потебном подградом и транспортом ископаног материјала до 5 km. Плаћа се по m^3 ископаног материјала - на дубини 0-2 m - на дубини 2-4 m	Excavate foundations in soil cat. I & II, place necessary timbering and haul excavated earth to 5 km distance. Payment per m^3 of excavated material - 0-2 m by depth - 2-4 m by depth	 m^3 m^3	 1,024.00 0.00	 890.00 1,200.00	 911,360.00 0.00
2/1.1.3.2.2.2		Насипање материјала / затрпавање темеља потпорног зида, из ископа или позајмишта, у слојевима по 30 cm, песком, са набијањем слојева до модула стшљивости Ms=30MPa. Плаћа се по m^3 набијеног материјала	Backfill pier foundations using sand from borrow pit, in 30 cm layers tamped to modulus of compresibility of Ms=30MPa. Payment per m^3 of tamped earth	m^3	853.00	1,800.00	1,535,400.00
2/1.1.3.2.2.3		Израда кегли, према пројекту, материјалом добијеним из усека или позајмишта са механичким набијањем у слојевима од по 30cm.	Build newly designed backwalls of earth recovered from cuttings or borrow pits and tamp them mechanically, 30 cm layers.	m^3	1.00	3,700.00	3,700.00
		УКУПНО ЗЕМЉАНИ РАДОВИ:	**TOTAL EARTH WORKS:**				**2,450,460.00**

ПРОЈЕКАТ ЗА ГРАЂЕВИНСКУ ДОЗВОЛУ

Пруга Београд - Суботица - државна граница (Келебија), ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)

2/1 ПРОЈЕКАТ КОНСТРУКЦИЈА

2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03
Потпорни зидови

DESIGN FOR BUILDING PERMIT

Railway line Belgrade - Subotica - State border (Kelebia), SECTION NOVI SAD - SUBOTICA - STATE BORDER (KELEBIJA)

2/1 DESIGN OF CONSTRUCTIONS

2/1.1.3.2 Retaining walls adjacent to the gallery at km 78+377.03
Retaining walls

Бр. поз. No.	Бр.поз. Техн Усл Item in Tech. Conditions	Опис радова	Description	Јед. мере Unit	Количина Quantity	Јед. цена (дин) Unit rate (Din)	Цена (дин) Price (Din)
					A	B	A´B
2/1.1.3.2.2.3	**04**	**БЕТОНСКИ И АРМИРАНОБЕТОНСКИ РАДОВИ**	**PLAIN AND REINFORCED CONCRETE**				
		Све позиције обухватају поред описа појединачних ставки и следеће заједничке услове : - Бетонски радови ће бити изведени у свему по пројекту, статичком прорачуну и важећим правилницима. Цене садрже све радне операције, утрошке материјала, помоћни алат, оплате и скеле које прописују "Нормативи и стандарди рада у грађевинарству-Високоградња ГН 400", као и остале трошкове и зараду предузећа. - Бетон ће бити справљен, транспортован, уграђен, негован и испитиван на пробним узорцима по одредбама SRPS EN 206 за бетон. - Бетон ће бити справљен од агрегата и цемента атестираних по важећим српским стандардима. - Бетон класе B.II мора имати све класе отпорности дефинисане појединачним позицијама. - Обрачун количина стварно изведених радова извршиће се према одредбама које прописују "Нормативи и стандарди рада у грађевинарству". -Мешање бетона мора се вршити машинским путем, а набијање вибрирањем -Арматура се плаћа посебно -Каблови се плаћају посебно -У цену бетона је урачуната оплата и скела -Плаћа се за потпуно готов посао од m³ уграђеног бетона					
	04.01	**Неармирани бетон**	**Plain concrete**				
2/1.1.3.2.3.1		Мршави бетон - изравњавајући слој, дебљине 10 cm, C12/15, испод темеља стубова, крилних зидова, темељних плоча, наглавних греда, прелазних плоча од бетона.	Cast lean concrete C12/15 for 10 cm thick blinding layers under pier foundations, wing walls, foundation slabs, pile caps, transition slabs.	m^3	25.50	12,000.00	306,000.00
	04.02	**Армирано бетонске конструкције**	**Reinforced concrete structures**				
2/1.1.3.2.3.2		Армирани бетон темеља потпорних зидова. Бетон класе : C 25/30, XC2, PVII	Cast reinforced concrete in retaining wall foundations Concrete class: C 25/30, XC2,PVII	m^3	354.30	21,600.00	7,652,880.00
2/1.1.3.2.3.4		Армирани бетон за потпорне зидове од бетона класе C 25/30, XC4, XF1, PV-I	Cast reinforced concrete in retaining walls of concrete class C 25/30, XC4, XF1, PV-I	m^3	175.90	27,600.00	4,854,840.00
2/1.1.3.2.3.5		Ивични венци пешачких стаза ливени на лицу места, (укључујући и ревизионе шахтове) од бетона класе C 40/50, XC4, XD3, XF4, PV-II	Cast in situ footway cornices (with inspection chambers) of concrete class C 40/50, XC4, XD3, XF4, PV-II	m^3	0.00	37,200.00	0.00
		УКУПНО БЕТОНСКИ РАДОВИ:	**TOTAL FOR CONCRETING:**				**12,813,720.00**

ПРОЈЕКАТ ЗА ГРАЂЕВИНСКУ ДОЗВОЛУ

Пруга Београд - Суботица - државна граница (Келебија), ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)

2/1 ПРОЈЕКАТ КОНСТРУКЦИЈА

2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03
Потпорни зидови

DESIGN FOR BUILDING PERMIT

Railway line Belgrade - Subotica - State border (Kelebia), SECTION NOVI SAD - SUBOTICA - STATE BORDER (KELEBIJA)

2/1 DESIGN OF CONSTRUCTIONS

2/1.1.3.2 Retaining walls adjacent to the gallery at km 78+377.03
Retaining walls

Бр. поз. No.	Бр.поз. Техн Усл Item in Tech. Conditions	Опис радова	Description	Јед. мере Unit	Количина Quantity	Јед. цена (дин) Unit rate (Din)	Цена (дин) Price (Din)
					A	B	A´B
2/1.1.3.2.4	**05**	**РАДОВИ ОД МЕТАЛА**	**METALWORK**				
		Све позиције обухватају поред описа појединачних ставки и следеће заједничке услове: - Армирачки радови ће бити изведени у свему по пројекту, статичком прорачуну и важећим правилницима. Цене садрже све радне операције, утрошке материјала, помоћни алат и скеле које прописују "Нормативи и стандарди рада у грађевинарству-Високоградња ГН 400", као и остале трошкове и зараду предузећа. - Арматуру очистити од рђе и прљавштине, исправити, исећи, савити и уградити по детаљима (арамтурним нацртима) и статичком прорачуну. - За квалитет уграђене арматуре одговара извођач радова. - Јединична цена садржи и постављање подметача од челика,пластике или бетона за постизање предвиђених заштитних слојева и правилног положаја арматуре у конструкцији. Сва подеона гвожђа и узенгије ће бити чврсто везани за главну арматуру тако да не може доћи до промене положаја арматуре за време бетонирања конструкције. - Стварно уграђена количина арматуре свих квалитета обрачунава се по kg без обзира на сложеност и пречнике шипки арматуре. - Обрачун количина извршити према табличним тежинама арматуре и ужади и дужинама из арматурних нацрта.					
2/1.1.3.2.4.1		Набавка, чишћење, сечење, машинско савијање и монтажа арматуре према пропису, пројекту и статичким детаљима. Плаћа се по kg уграђене арматуре. Ребраста арматура B 500B	Purchase, wire brush, cut, bend mechanically and position bars according to the regulation, the design and the static detailed drawings. Payment per kg of positioned bars. Ribbed reinforcement B 500B	kg	79,530.00	120.00	9,543,600.00
		УКУПНО АРМИРАЧКИ РАДОВИ:	**TOTAL METALWORK:**				**9,543,600.00**

ПРОЈЕКАТ ЗА ГРАЂЕВИНСКУ ДОЗВОЛУ

Пруга Београд - Суботица - државна граница (Келебија), ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)

2/1 ПРОЈЕКАТ КОНСТРУКЦИЈА

2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03
Потпорни зидови

DESIGN FOR BUILDING PERMIT

Railway line Belgrade - Subotica - State border (Kelebia), SECTION NOVI SAD - SUBOTICA - STATE BORDER (KELEBIJA)

2/1 DESIGN OF CONSTRUCTIONS

2/1.1.3.2 Retaining walls adjacent to the gallery at km 78+377.03
Retaining walls

Бр. поз. No.	Бр.поз. Техн Усл Item in Tech. Conditions	Опис радова	Description	Јед. мере Unit	Количина Quantity	Јед. цена (дин) Unit rate (Din)	Цена (дин) Price (Din)
					A	B	A´B
2/1.1.3.2.5	**06**	**ИЗОЛАТЕРСКИ РАДОВИ**	**WATERPROOFING**				
		- Сви изолатерски радови морају бити изведени педантно и тачно према захтевима из пројекта, предрачуна радова и детаљима. - Употребљени материјали морају одговарати важећим стандардима и прописима, снабдевени атестима овлашћене установе, проверени у употреби, трајни колико и објекат или пројектовани тако да је њихова замена могућа. - Све грешке на конструкцији морају се на одговарајући начин отклонити или санирати пре почетка наношења изолационог материјала. - У јединичну цену је урачуната набавка свог потребног материјала, алата, транспорт и израда. - Плаћа се за потпуно готов посао по m^2 урађене изолације и/или заштите.					
2/1.1.3.2.5.1		Израда хидроизолације круне зида испод ивичног венца на бази метил метакрилата, прскањем под притиском. Радови по овој позицији се изводе у складу са техничким условима и нормативима за ову врсту послова као и по технологији произвођача. У цену су у рачунати набавка материјала, транспорт и уградња.	Spray under pressurea layer of waterproofing material based on methyl metacrilate on wall surface below cornices. Work against this item shall conform to the relevant technical conditions and standards, and the manufacturer's technology. The price includes purchase of materials, transport and application.	m^2	0.00	4,150.00	0.00
2/1.1.3.2.5.2		Израда хидроизолације од једног хладног премаза битулитом и једног премаза врућим битуменом бетонских површина које су у контакту са земљом.	Apply waterproofing of one cold coat of bitumen emulsion and one hot bitumen coat onto concrete surfaces in contact with ground.	m^2	585.00	1,200.00	702,000.00
2/1.1.3.2.5.3		Израда заштите бетонских површина заштитним хидрофобним премазом за бетон, на бази пенетрата. Површине морају бити претходно очишћене и суве. Премазивање подразумева заштиту и импрегнацију свих видљивих бетонских површина моста које су у додиру са атмосферским утицајима.	Protect concrete surfaces with protective hydrophobic penetrat-based coats. Surfaces shall be clean and dry prior to application. This means that all visible concrete surfaces on the bridge exposed to atmosphere shall be coated for the purpose of protection and impregnation.	m^2	161.00	2,000.00	322,000.00
2/1.1.3.2.5.4		Заштитни премаз бетона на пешачким стазама, степеницама и подестима, d=3-3.5 mm, формираног од 4 слоја:епокси прајмер, водоотпорни слој пур смоле, основни премаз пур смоле(полиуретан) са кварц песком (0.5-1 mm) и завршни слој пур смоле.	Apply protective coats onto concrete surface on footways, steps and landings, 3-3.5 mm thick, 4-ply of epoxy primer, water repellent pur resin, base coat of pur resin (polyurethane) with quartz sand (0.5-1 mm) and top coat of pur resin.	m^2	0.00	2,500.00	0.00
		УКУПНО ИЗОЛАТЕРСКИ РАДОВИ:	**TOTAL WATERPROOFING:**				**1,024,000.00**

ПРОЈЕКАТ ЗА ГРАЂЕВИНСКУ ДОЗВОЛУ

Пруга Београд - Суботица - државна граница (Келебија), ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)

2/1 ПРОЈЕКАТ КОНСТРУКЦИЈА

2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03
Потпорни зидови

DESIGN FOR BUILDING PERMIT

Railway line Belgrade - Subotica - State border (Kelebia), SECTION NOVI SAD - SUBOTICA - STATE BORDER (KELEBIJA)

2/1 DESIGN OF CONSTRUCTIONS

2/1.1.3.2 Retaining walls adjacent to the gallery at km 78+377.03
Retaining walls

Бр. поз. No.	Бр.поз. Техн Усл Item in Tech. Conditions	Опис радова	Description	Јед. мере Unit	Количина Quantity	Јед. цена (дин) Unit rate (Din)	Цена (дин) Price (Din)
					A	B	A´B
2/1.1.3.2.6	**07**	**СПОЈНИЦЕ**	**JOINTS**				
2/1.1.3.2.6.1		Дилатације између кампада: гумена трака за заптивање ка засипу, завршна гумена трака или трајно еластична маса ка спољној страни зида и испуна споја (пенаста маса).	Expansion joints between two segments: sealing rubber strip facing backfill, rubber dilatation joint or permanently elastic material on front side and fill of joint (foam material).	m'	23.50	9,500.00	223,250.00
2/1.1.3.2.6.2		Додирне спојнице назубљеног облика са гуменом траком за заптивање ка засипу и троугаоним вертикалним утором 2 x 1,5 x 1,5 cm споља.	Contact joints, ribbed shape, with sealing rubber strip facing backfill, and triangular vertical slots 2 x 1.5 x 1.5 cm on front side.	m'	15.20	8,000.00	121,600.00
УКУПНО ЛЕЖИШТА И ДИЛАТАЦИЈЕ: TOTAL BEARINGS AND EXPANSION JOINTS:							**344,850.00**
2/1.1.3.2.7	**08**	**ОСТАЛИ РАДОВИ**	**MISCELLANEOUS**				
		За све позиције наведених радова важи: * у цену је урачуната набавка свог потребног материјала, алата, механизације, транспорт, израда и монтажа према пројекту, а за комплетно завршен посао					
2/1.1.3.2.7.1		Израда и постављање ограде од челика S 235 JRG1. У цену је урачуната набавка материјала, израда, транспорт, монтажа, антикорозиона заштита са два основна и два завршна премаза покривном бојом, а у свему према пројекту. Плаћа се по kg постављене ограде. - цевне или од профила - висока жичана заштитна ограда	Assemble and erect railing and fence of S 235 JRG1 steel. The price includes purchase of material, assembly transport, erection, anticorrosive protection of two primers and two top coats of paint, fully as designed. Payment per kg of railing/fence. - tubular railing or sections - high protective fence of steel mesh	kg kg	0.00 0.00	250.00 250.00	0.00 0.00
2/1.1.3.2.7.2		Уграђивање ПВЦ цеви у пешачке (ревизионе) стазе Ф100mm. Плаћа се по m' уграђених цеви.	Insert PVC pipes in footways (inspection ways) Ф100mm. Payment per m' of inserted pipes.	m'	0.00	450.00	0.00
2/1.1.3.2.7.3		Израда и затварање спојница на контакту на асфалта и ивичњака трајно еластичном масом. Плаћа се по m' уграђене спојнице.	Prepare and close joints in concrete surface at the joints between asphalt and curb lines with durably elastic mass. Payment per m' of finished joint.	m'	0.00	3,000.00	0.00
2/1.1.3.2.7.4		Израда и затварање спојница на бетону на степенишном делу, уз ивичњаке и венце на пешачким стазама, трајно еластичном масом. Плаћа се по m' уграђене спојнице.	Prepare and close joints in concrete surface on the stairs, between curb lines and footway cornices a with durably elastic mass. Payment per m' of finished joint.	m'	0.00	3,000.00	0.00

ПРОЈЕКАТ ЗА ГРАЂЕВИНСКУ ДОЗВОЛУ

Пруга Београд - Суботица - државна граница (Келебија), ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)

2/1 ПРОЈЕКАТ КОНСТРУКЦИЈА

2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03
Потпорни зидови

DESIGN FOR BUILDING PERMIT

Railway line Belgrade - Subotica - State border (Kelebia), SECTION NOVI SAD - SUBOTICA - STATE BORDER (KELEBIJA)

2/1 DESIGN OF CONSTRUCTIONS

2/1.1.3.2 Retaining walls adjacent to the gallery at km 78+377.03
Retaining walls

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					A	B	A´B
2/1.1.3.2.7.5		Ивичњаци бетонски или камени 20/25 cm.	Place curbs of concrete or stone 20/25 cm	m'	0.00	2,600.00	0.00
2/1.1.3.2.7.6		Набавка, припрема и уградња репера за праћење деформација са повезивањем на постојећу нивелманску мрежу и нултим снимањем висине.	Procurement, preparation and installation of benchmarks for tracking deformation connecting the existing leveling networks and recording zero level.	ком	21.00	8,000.00	168,000.00
2/1.1.3.2.7.7		Набавка и постављање на подбетону дренаже са дренажном цеви ДН160 mm, обавијене геотекстилом, са испустима Ø 50 mm / 2 m кроз зидове. Плаћа се комплетан посао.	Supply and installation drainage and the drainage pipe DN160 mm at concrete underlay wrapped with geotextile, with discharges Ø 50 mm / 2 m through walls. Payment for the full job.	m'	46.00	3,200.00	147,200.00

УКУПНО ОСТАЛИ РАДОВИ:	**TOTAL MISCELLANEOUS:**	**315,200.00**

ЗБИРНА РЕКАПИТУЛАЦИЈА **GRAND SUMMARY**

2/1.1.3.2.1	**02**	**ИЗВОЂЕЊЕ HW ШИПОВА**	**HW PILES**	**8,424,164.00**
2/1.1.3.2.2	**03**	**ЗЕМЉАНИ РАДОВИ**	**EARTHWORKS**	**2,450,460.00**
2/1.1.3.2.2.3	**04**	**БЕТОНСКИ И АРМИРАНОБЕТОНСКИ РАДОВИ**	**PLAIN AND REINFORCED CONCRETE**	**12,813,720.00**
2/1.1.3.2.4	**05**	**РАДОВИ ОД МЕТАЛА**	**METALWORK**	**9,543,600.00**
2/1.1.3.2.5	**06**	**ИЗОЛАТЕРСКИ РАДОВИ**	**WATERPROOFING**	**1,024,000.00**
2/1.1.3.2.6	**07**	**СПОЈНИЦЕ**	**JOINTS**	**344,850.00**
2/1.1.3.2.7	**08**	**ОСТАЛИ РАДОВИ**	**MISCELLANEOUS**	**315,200.00**

УКУПНО (дин): **GRAND TOTAL (Din):** **34,915,994.00**

Београд, Април 2021.

Одговорни пројектант:

Зоран Луковић, дипл.грађ.инж
лиценца бр.: 310 3032 03

Belgrade, April 2021

Responsible designer:

Zoran Luković , grad.Civ.Eng.
Licence no.: 310 3032 03

2/1.1.3.2.7 ГРАФИЧКА ДОКУМЕНТАЦИЈА

ОСНОВА / PLAN VIEW

P / S 1:100

КАРАКТЕРИСТИКЕ МАТЕРИЈАЛА:

Елемент	Бетон	Арматура	Заштитни слој
АБ темељи потпорних зидова	C 25/30, XC2, PVII	B500B	5.0
АБ потпорни зидови	C 25/30, XC4, XF1, PV-I	B500B	5.0
Ивични венци и пешачке стазе	C 40/50, XC4, XD3, XF4, PV-II	B500B	4.5
Наглавне греде и темељи потп. конс.	C 30/37	B500B	5.0
Стубови потпорне конструкције	C 40/50, XC4, VI	B500B	5.0
Зидови потпорне конструкције	C 30/37, XC4, VI	B500B	5.0
Лежишне греде потп. конструкције	C 30/37, XC4, VI	B500B	5.0
Попречни носачи потп. конструкције	C 30/37, XC4, XD1, XF2, V-II	B500B	5.0
Шипови	C 30/37	B500B	9.0
Подбетон	C 12/15, X0		

MATERIAL PROPERTIES

Component	Concrete	Reinforcement	Clear cover
RC in retaining walls foundations	C 25/30, XC2, PVII	B500B	5.0
RC in retaining wals	C 25/30, XC4, XF1, PV-I	B500B	5.0
Edge beams and sidewalks	C 40/50, XC4, XD3, XF4, PV-II	B500B	4.5
Pile caps and ret. const. foundations	C 30/37	B500B	5.0
Piers of retaining construction	C 40/50, XC4, VI	B500B	5.0
Walls of retaining construction	C 30/37, XC4, VI	B500B	5.0
Bearing beams of retaining construction	C 30/37, XC4, VI	B500B	5.0
Cross girders of retaining construction	C 30/37, XC4, XD1, XF2, V-II	B500B	5.0
Piles	C 30/37	B500B	9.0
Lean concrete	C 12/15, X0		

Број/Number	Датум / Date	Опис / Description
03		
02		
01		

Ревизиони блок: / Revision block:

CRDC 中国铁设

China Railway Design Corporation Serbia
Ogranak Beograd
Косте Рацина 16б; 11000 Београд; Србија

Организациона јединица: ГРАЂЕВИНАРСТВО И САОБРАЋАЈ
Organization unit: DEPARTMENT OF CIVIL AND TRANSPORTATION

Одговорни пројектант: Responsible designer:
Зоран Луковић, дипл.грађ.инж
лиценца број:/ license No.: 310 3032 03

Сарадници: / Associates:

Инвеститор пројекта: / Investor:
" ИНФРАСТРУКТУРА ЖЕЛЕЗНИЦЕ СРБИЈЕ " А.Д.
/ " INFRASTRUCTURE RAILWAYS OF SERBIA " JSC
Немањина 6/IV, Београд / Nemanjina Street 6/IV, Belgrade

Наручилац пројекта: / Employer:
China Railway International Corporation Ltd. No.10 Fuxing Road,Haidian District,Beijing P.R China, 100844
China Communication Construction Company Ltd. (CCCC) No.85 Deshengmenwai Street,Xicheng District,Beijing P.R China, 100088

Објекат: /Structure:
ПРУГА БЕОГРАД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
BELGRADE - SUBOTICA - STATE BORDER (KELEBIA) RAILWAY LINE
SECTION : NOVI SAD - SUBOTICA - STATE BORDER (KELEBIA)

Део пројекта: / Part of Design:
ПРОЈЕКАТ КОНСТРУКЦИЈА / DESIGN OF CONSTRUCTION

2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03
2/1.1.3.2 Retaining walls adjacent to the gallery at km 78+377.03

Унутрашња контрола: / Internal control:
Hou Jieping. Master & Shi Wei. Bachelor

Главни пројектант: / Chief designer:
др Љиљана Милић Марковић, дипл.грађ.инж.

Руководилац организационе јединице: Manager of organization unit:
др Љиљана Милић Марковић, дипл.грађ.инж.

Цртеж:/ Drawing: ОСНОВА PLAN VIEW

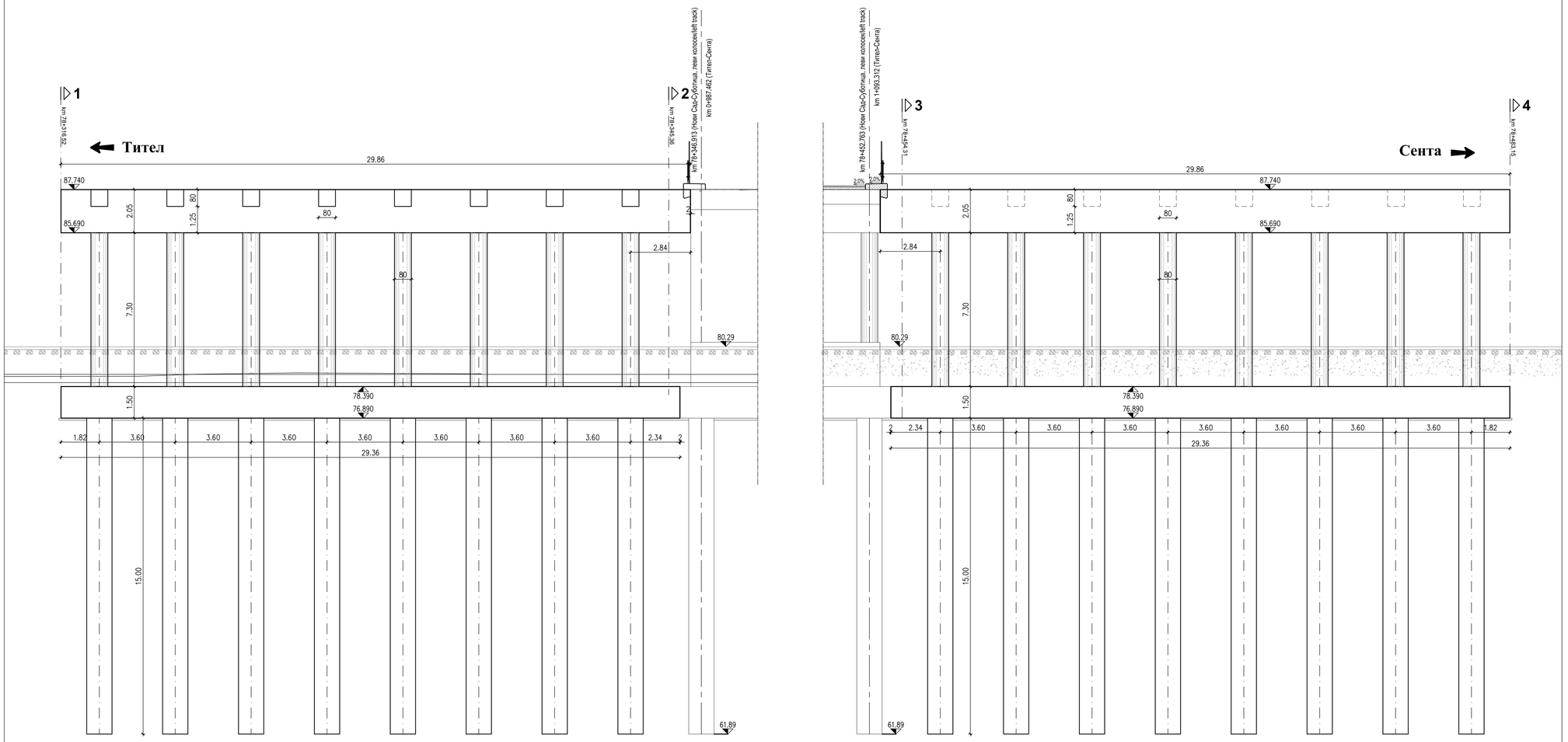
Размера: Scale: 1:100

Врста тех. док.: Type of tech. docum.: ПГД / DCP

датум:/date: 04.2021.

Цртеж бр./Drawing No.: 2020-001-ГС-2/1.1.3.2.7.Ц01.

PODUŽNI ПРЕСЕК A-A
LONGITUDINAL SECTION A-A



КАРАКТЕРИСТИКЕ МАТЕРИЈАЛА:

Елемент	Бетон	Арматура	Заштитни слој
АБ темељи потпорних зидова	C 25/30, XC2, PVII	B500B	5.0
АБ потпорни зидови	C 25/30, XC4, XF1, PV-I	B500B	5.0
Ивични венци и пешачке стазе	C 40/50, XC4, XD3, XF4, PV-II	B500B	4.5
Наглавне греде и темељи потп. конс.	C 30/37	B500B	5.0
Стубови потпорне конструкције	C 40/50, XC4, VI	B500B	5.0
Зидови потпорне конструкције	C 30/37, XC4, VI	B500B	5.0
Лежишне греде потп. конструкције	C 30/37, XC4, VI	B500B	5.0
Попречни носачи потп. конструкције	C 30/37, XC4, XD1, XF2, V-II	B500B	5.0
Шипови	C 30/37	B500B	9.0
Подбетон	C 12/15, X0		

MATERIAL PROPERTIES

Component	Concrete	Reinforcement	Clear cover
RC in retaining walls foundations	C 25/30, XC2, PVII	B500B	5.0
RC in retaining wals	C 25/30, XC4, XF1, PV-I	B500B	5.0
Edge beams and sidewalks	C 40/50, XC4, XD3, XF4, PV-II	B500B	4.5
Pile caps and ret. const. foundations	C 30/37	B500B	5.0
Piers of retaining construction	C 40/50, XC4, VI	B500B	5.0
Walls of retaining construction	C 30/37, XC4, VI	B500B	5.0
Bearing beams of retaining construction	C 30/37, XC4, VI	B500B	5.0
Cross girders of retaining construction	C 30/37, XC4, XD1, XF2, V-II	B500B	5.0
Piles	C 30/37	B500B	9.0
Lean concrete	C 12/15, X0		

Број/Number	Датум / Date	Опис / Description
03		
02		
01		

Ревизиони блок: / Revision block:

中国铁设 CRDC

China Railway Design Corporation Serbia
Ogranak Beograd
Косте Рацина 16б; 11000 Београд; Србија

Организациона јединица: ГРАЂЕВИНАРСТВО И САОБРАЋАЈ
Organization unit: DEPARTMENT OF CIVIL AND TRANSPORTATION

Одговорни пројектант:
Responsible designer:
Зоран Луковић, дипл.грађ.инж
лиценца број:/ license No.: 310 3032 03

Сарадници: / Associates:

Инвеститор пројекта: / Investor:
" ИНФРАСТРУКТУРА ЖЕЛЕЗНИЦЕ СРБИЈЕ " А.Д.
/ " INFRASTRUCTURE RAILWAYS OF SERBIA " JSC
Немањина 6/IV, Београд / Nemanjina Street 6/IV, Belgrade

Наручилац пројекта: / Employer:
China Railway International Corporation Ltd.
No.10 Fuxing Road,Haidian District,Beijing
P.R.China, 100844
China Communication Construction Company Ltd. (CCCC)
No.85 Deshengmenwai Street,Xicheng District,Beijing
P.R.China, 100088

Објекат: /Structure:
ПРУГА БЕОГРАД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
BELGRADE - SUBOTICA - STATE BORDER (KELEBIA) RAILWAY LINE
SECTION : NOVI SAD - SUBOTICA - STATE BORDER (KELEBIA)

Део пројекта: / Part of Design:
ПРОЈЕКАТ КОНСТРУКЦИЈА / DESIGN OF CONSTRUCTION

2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03
2/1.1.3.2 Retaining walls adjacent to the gallery at km 78+377.03

Унутрашња контрола: / Internal control:
Hou Jieping. Master & Shi Wei. Bachelor

Главни пројектант: / Chief designer:
др Љиљана Милић Марковић, дипл.грађ.инж.

Цртеж: / Drawing:
ПОДУЖНИ ПРЕСЕК A-A
LONGITUDINAL SECTION A-A

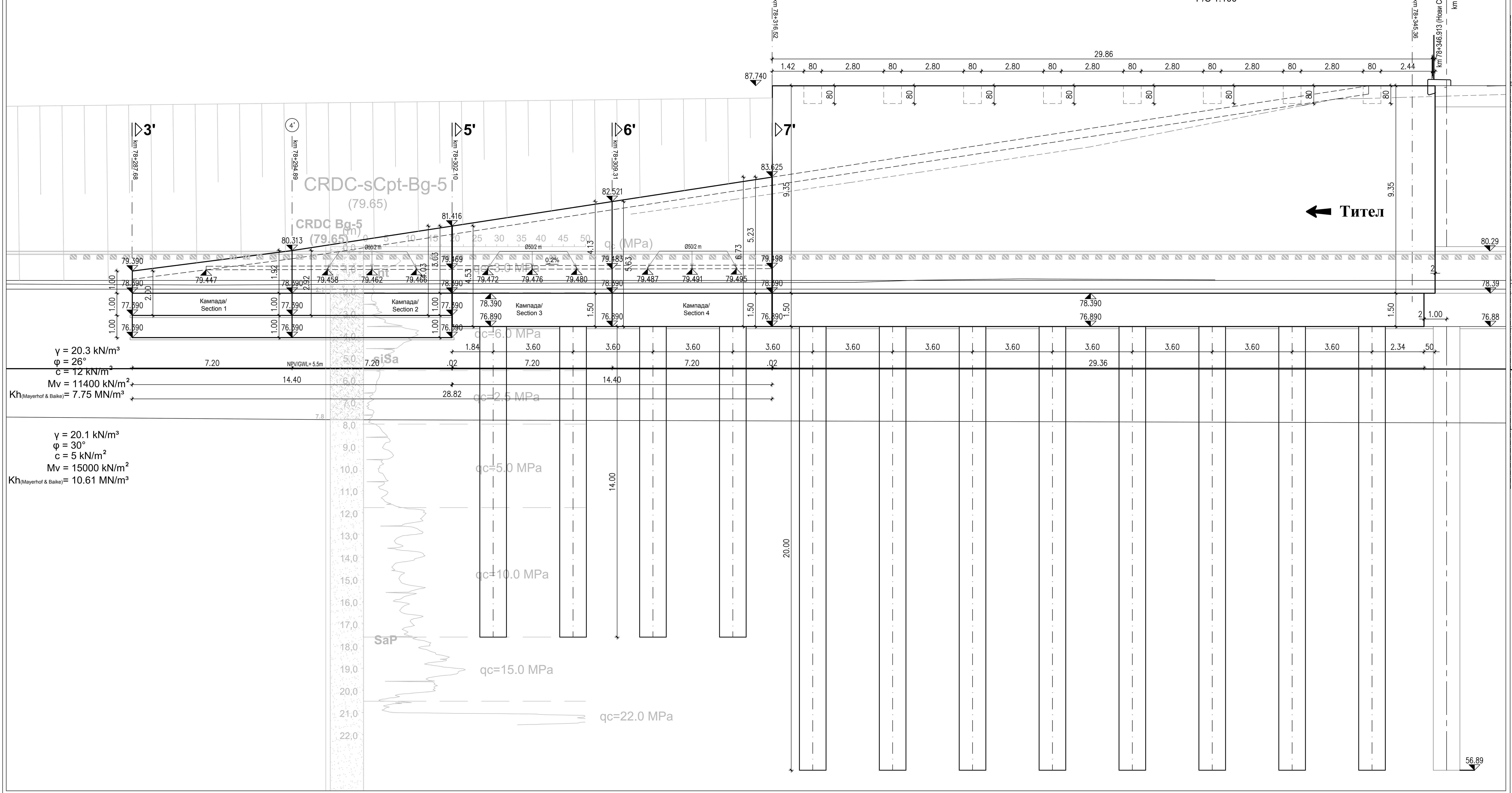
Размера: Scale: 1:100

Руководилац организационе јединице:
Manager of organization unit:
др Љиљана Милић Марковић, дипл.грађ.инж.

Врста тех. док.: Type of tech. docum.:	датум /date:	Цртеж бр. /Drawing No.:
ПГД / DCP	04.2021.	2020-001-ГС-2/1.1.3.2.7.Ц02.

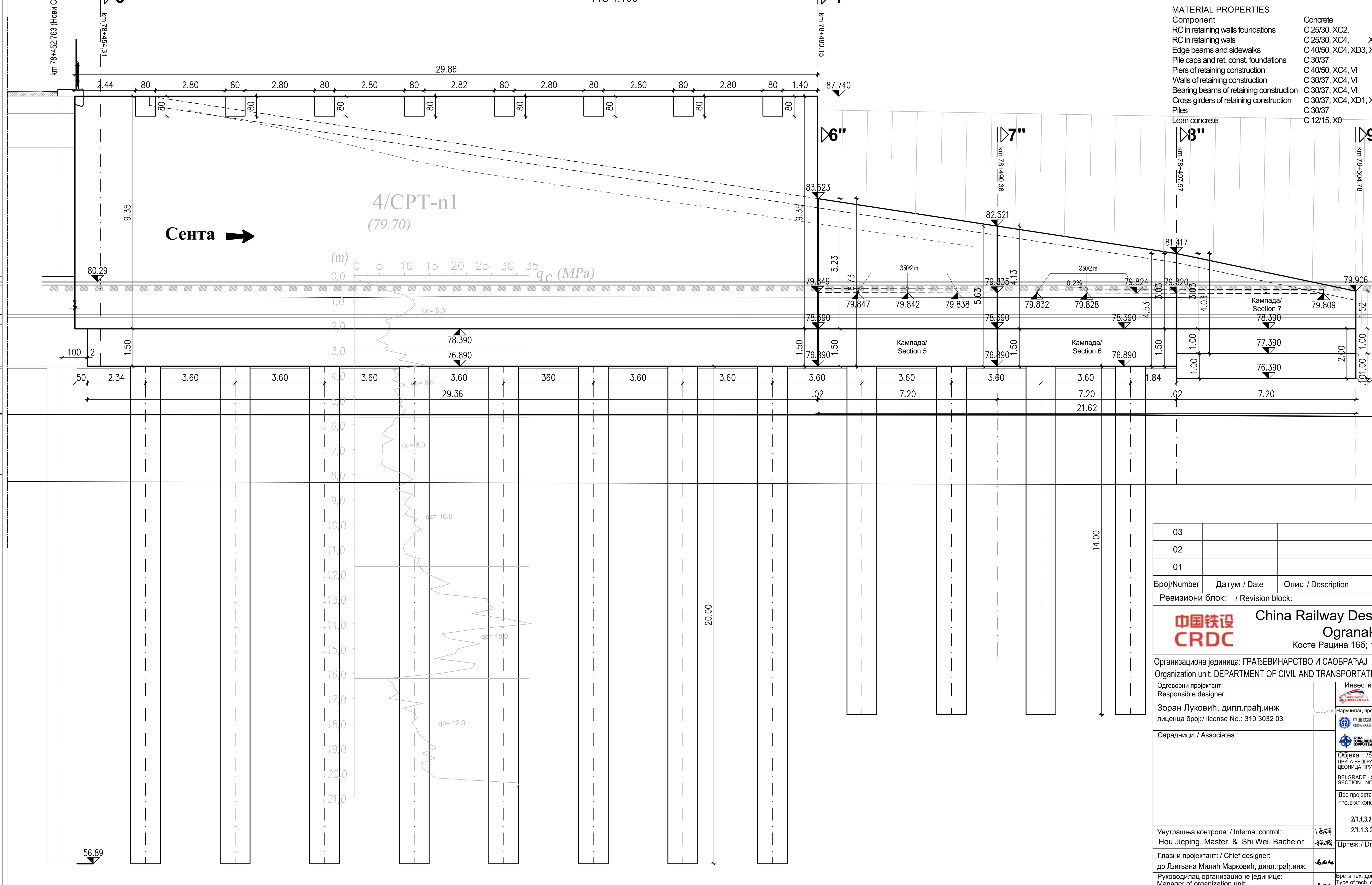
PODUŽNI ПРЕСЕК B-B
LONGITUDINAL SECTION B-B

P/S 1:100



PODUŽNI ПРЕСЕК C-C
LONGITUDINAL SECTION C-C

P/S 1:100



КАРАКТЕРИСТИКЕ МАТЕРИЈАЛА:

Елемент	Бетон	Арматура	Заштитни слој
АБ темељи потпорних зидова	C 25/30, XC2, PVII	B500B	5.0
АБ потпорни зидови	C 25/30, XC4, XF1, PV-I	B500B	5.0
Ивични венци и пешачке стазе	C 40/50, XC4, XD3, XF4, PV-II	B500B	4.5
Наглавне греде и темељи потп. конс.	C 30/37	B500B	5.0
Стубови потпорне конструкције	C 40/50, XC4, VI	B500B	5.0
Зидови потпорне конструкције	C 30/37, XC4, VI	B500B	5.0
Лежишне греде потп. конструкције	C 30/37, XC4, VI	B500B	5.0
Попречни носачи потп. конструкције	C 30/37, XC4, XD1, XF2, V-II	B500B	5.0
Шипови	C 30/37	B500B	9.0
Подбетон	C 12/15, X0		

MATERIAL PROPERTIES

Component	Concrete	Reinforcement	Clear cover
RC in retaining walls foundations	C 25/30, XC2, PVII	B500B	5.0
RC in retaining wals	C 25/30, XC4, XF1, PV-I	B500B	5.0
Edge beams and sidewalks	C 40/50, XC4, XD3, XF4, PV-II	B500B	4.5
Pile caps and ret. const. foundations	C 30/37	B500B	5.0
Piers of retaining construction	C 40/50, XC4, VI	B500B	5.0
Walls of retaining construction	C 30/37, XC4, VI	B500B	5.0
Bearing beams of retaining construction	C 30/37, XC4, VI	B500B	5.0
Cross girders of retaining construction	C 30/37, XC4, XD1, XF2, V-II	B500B	5.0
Piles	C 30/37	B500B	9.0
Lean concrete	C 12/15, X0		

Број/Number	Датум / Date	Опис / Description
03		
02		
01		

Ревизиони блок: / Revision block:

中国铁设 CRDC

China Railway Design Corporation Serbia
Ogranak Beograd
Косте Рацина 16б; 11000 Београд; Србија

Организациона јединица: ГРАЂЕВИНАРСТВО И САОБРАЋАЈ
Organization unit: DEPARTMENT OF CIVIL AND TRANSPORTATION

Одговорни пројектант: / Responsible designer:
Зоран Луковић, дипл.грађ.инж
лиценца број:/ license No.: 310 3032 03

Сарадници: / Associates:

Инвеститор пројекта: / Investor:
" ИНФРАСТРУКТУРА ЖЕЛЕЗНИЦЕ СРБИЈЕ " А.Д.
/ " INFRASTRUCTURE RAILWAYS OF SERBIA " JSC
Немањина 6/IV, Београд / Nemanjina Street 6/IV, Belgrade

Наручилац пројекта: / Employer:
China Railway International Corporation Ltd. No.10 Fuxing Road,Haidian District,Beijing P.R China, 100844
China Communication Construction Company Ltd. (CCCC) No.85 Deshengmenwai Street,Xicheng District,Beijing P.R China, 100088

Објекат: /Structure:
ПРУГА БЕОГРАД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
BELGRADE - SUBOTICA - STATE BORDER (KELEBIA) RAILWAY LINE
SECTION : NOVI SAD - SUBOTICA - STATE BORDER (KELEBIA)

Део пројекта: / Part of Design:
ПРОЈЕКАТ КОНСТРУКЦИЈА / DESIGN OF CONSTRUCTION

2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03
2/1.1.3.2 Retaining walls adjacent to the gallery at km 78+377.03

Унутрашња контрола: / Internal control:
Hou Jieping. Master & Shi Wei. Bachelor

Главни пројектант: / Chief designer:
др Љиљана Милић Марковић, дипл.грађ.инж.

Руководилац организационе јединице:
Manager of organization unit:
др Љиљана Милић Марковић, дипл.грађ.инж.

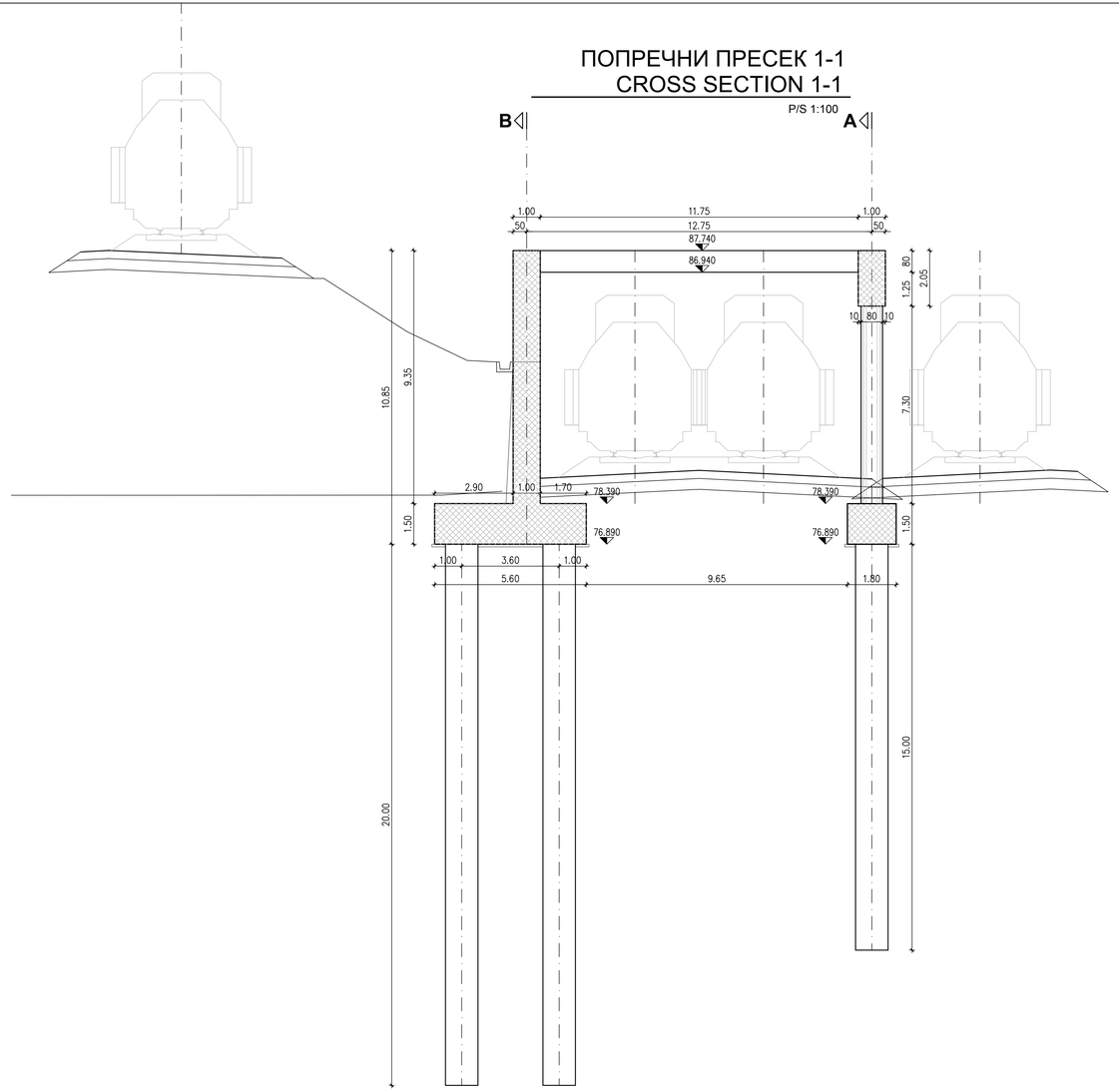
Цртеж:/ Drawing:
ПОДУЖНИ ПРЕСЕК B-B И C-C
LONGITUDINAL SECTION B-B AND C-C

Размера: Scale: 1:100

Врста тех. док.: / Type of tech. docum.: ПГД / DCP
датум:/date: 04.2021.
Цртеж бр./Drawing No.: 2020-001-ГС-2/1.1.3.2.7.Ц03.

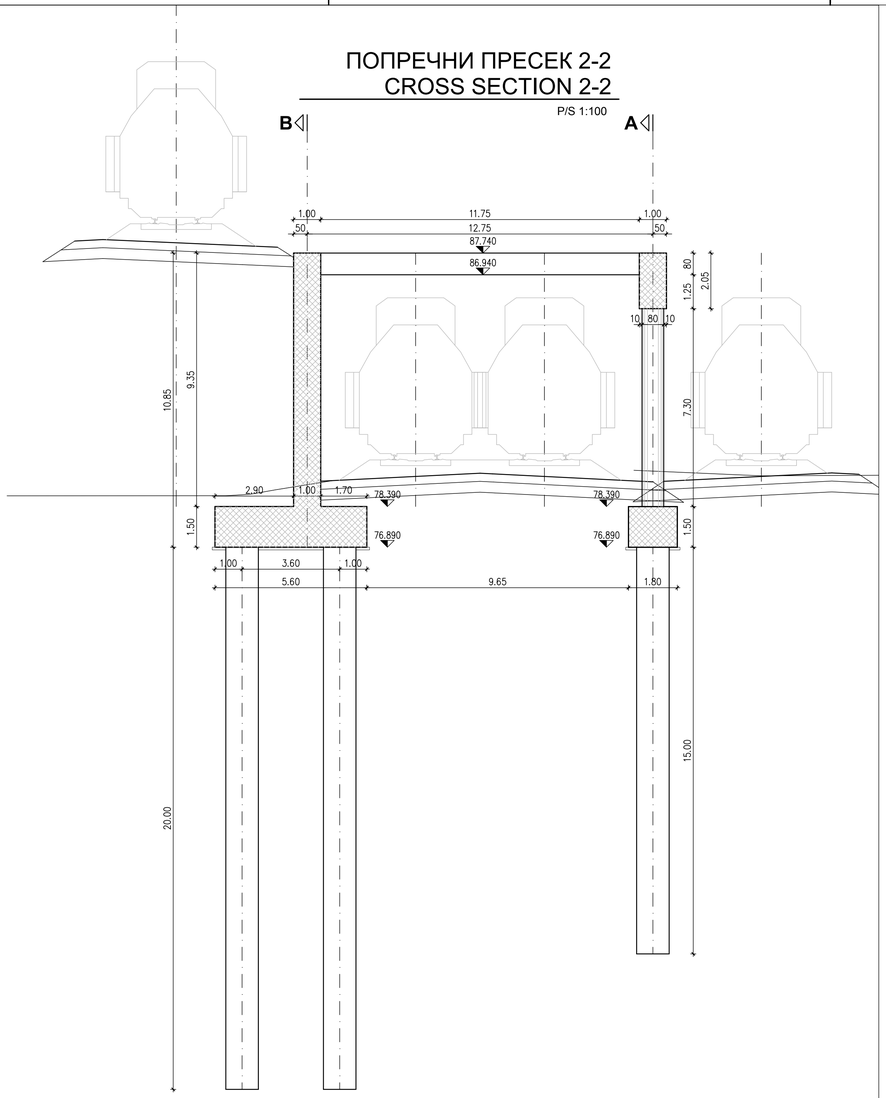
ПОПРЕЧНИ ПРЕСЕК 1-1
CROSS SECTION 1-1

P/S 1:100



ПОПРЕЧНИ ПРЕСЕК 2-2
CROSS SECTION 2-2

P/S 1:100



КАРАКТЕРИСТИКЕ МАТЕРИЈАЛА:

Елемент	Бетон	Арматура	Заштитни слој
АБ темељи потпорних зидова	C 25/30, XC2, PVII	B500B	5.0
АБ потпорни зидови	C 25/30, XC4, XF1, PV-I	B500B	5.0
Ивични венци и пешачке стазе	C 40/50, XC4, XD3, XF4, PV-II	B500B	4.5
Наглавне греде и темељи потп. конс.	C 30/37	B500B	5.0
Стубови потпорне конструкције	C 40/50, XC4, VI	B500B	5.0
Зидови потпорне конструкције	C 30/37, XC4, VI	B500B	5.0
Лежишне греде потп. конструкције	C 30/37, XC4, VI	B500B	5.0
Попречни носачи потп. конструкције	C 30/37, XC4, XD1, XF2, V-II	B500B	5.0
Шипови	C 30/37	B500B	9.0
Подбетон	C 12/15, X0		

MATERIAL PROPERTIES

Component	Concrete	Reinforcement	Clear cover
RC in retaining walls foundations	C 25/30, XC2, PVII	B500B	5.0
RC in retaining wals	C 25/30, XC4, XF1, PV-I	B500B	5.0
Edge beams and sidewalks	C 40/50, XC4, XD3, XF4, PV-II	B500B	4.5
Pile caps and ret. const. foundations	C 30/37	B500B	5.0
Piers of retaining construction	C 40/50, XC4, VI	B500B	5.0
Walls of retaining construction	C 30/37, XC4, VI	B500B	5.0
Bearing beams of retaining construction	C 30/37, XC4, VI	B500B	5.0
Cross girders of retaining construction	C 30/37, XC4, XD1, XF2, V-II	B500B	5.0
Piles	C 30/37	B500B	9.0
Lean concrete	C 12/15, X0		

Број/Number	Датум / Date	Опис / Description
03		
02		
01		

Ревизиони блок: / Revision block:

China Railway Design Corporation Serbia
Ogranak Beograd
Косте Рацина 166; 11000 Београд; Србија

Организациона јединица: ГРАЂЕВИНАРСТВО И САОБРАЋАЈ
Organization unit: DEPARTMENT OF CIVIL AND TRANSPORTATION

Одговорни пројектант:
Responsible designer:
Зоран Луковић, дипл.грађ.инж
лиценца број: / license No.: 310 3032 03

Сарадници: / Associates:

Инвеститор пројекта: / Investor:
" ИНФРАСТРУКТУРА ЖЕЛЕЗНИЦЕ СРБИЈЕ " А.Д.
/ " INFRASTRUCTURE RAILWAYS OF SERBIA " JSC
Немањина 6/IV, Београд, / Nemanjina Street 6/IV, Belgrade

Надзирачки пројекта: / Employer:
China Railway International Corporation Ltd.
No.15 Fuxing Road Haidian District,Beijing
P.R.China,100044
China Communications Construction Company Ltd. (CCCC)
No.85 Deshengmenwai Street,Xicheng District,Beijing
P.R.China, 100088

Објекат: /Structure:
ПРУГА БЕОГРАД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
BELGRADE - SUBOTICA - STATE BORDER (KELEBIA) RAILWAY LINE
SECTION : NOVI SAD - SUBOTICA - STATE BORDER (KELEBIA)

Део пројекта: / Part of Design:
ПРОЈЕКАТ КОНСТРУКЦИЈА / DESIGN OF CONSTRUCTION

2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03
2/1.1.3.2 Retaining walls adjacent to the gallery at km 78+377.03

Унутрашња контрола: / Internal control:
Hou Jieping. Master & Shi Wei. Bachelor

Главни пројектант: / Chief designer:
др Љиљана Милић Марковић, дипл.грађ.инж.

Руководилац организационе јединице:
Manager of organization unit:
др Љиљана Милић Марковић, дипл.грађ.инж.

Цртеж: / Drawing:
ПОПРЕЧНИ ПРЕСЕК 1-1 И 2-2
CROSS SECTION 1-1 AND 2-2

Размера:
Scale:
1:100

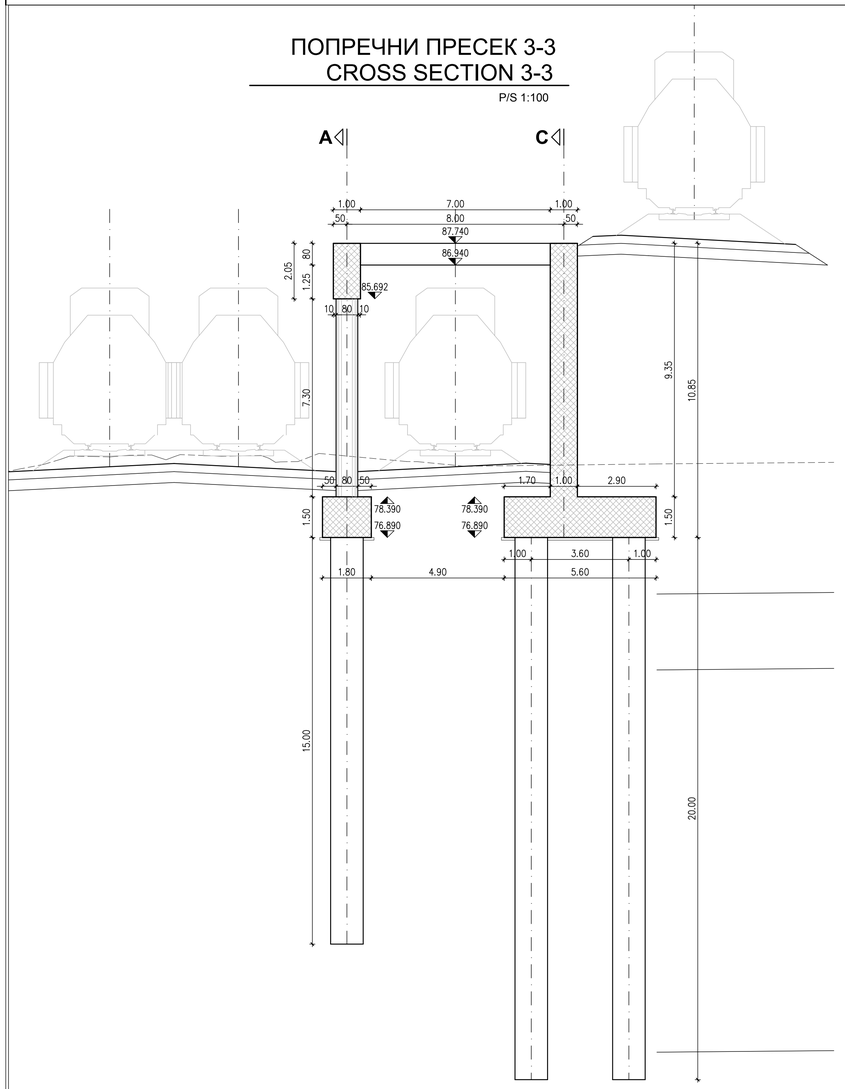
Врста тех. док.:
Type of tech. docum.:
ПГД / DCP

Датум /date:
04.2021.

Цртеж бр. /Drawing No.:
2020-001-ГС-2/1.1.3.2.7.Ц04.

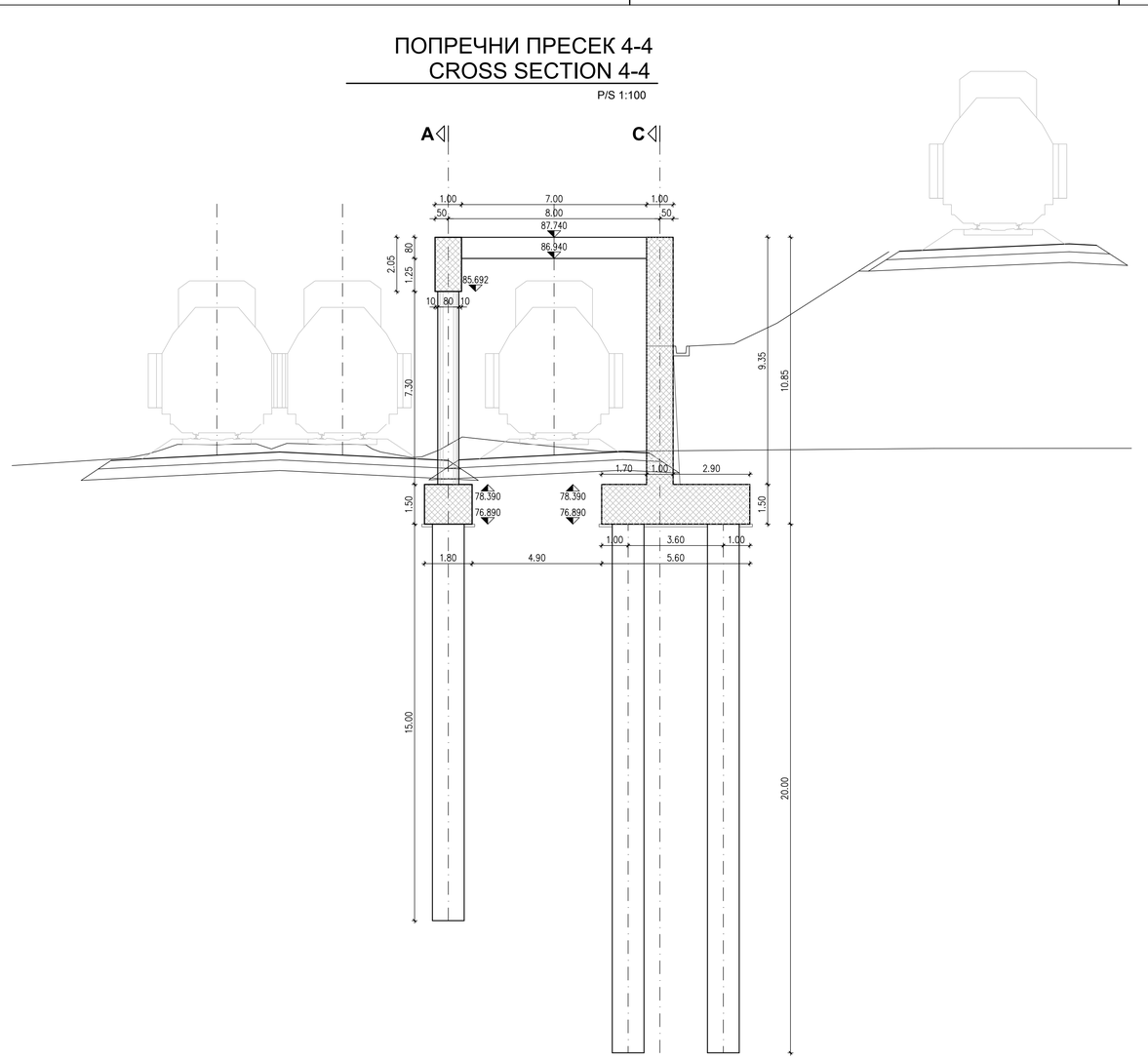
ПОПРЕЧНИ ПРЕСЕК 3-3
CROSS SECTION 3-3

P/S 1:100



ПОПРЕЧНИ ПРЕСЕК 4-4
CROSS SECTION 4-4

P/S 1:100



КАРАКТЕРИСТИКЕ МАТЕРИЈАЛА:

Елемент	Бетон	Арматура	Заштитни слој
АБ темељи потпорних зидова	C 25/30, XC2, PVII	B500B	5.0
АБ потпорни зидови	C 25/30, XC4, XF1, PV-I	B500B	5.0
Ивични венци и пешачке стазе	C 40/50, XC4, XD3, XF4, PV-II	B500B	4.5
Наглавне греде и темељи потп. конс.	C 30/37	B500B	5.0
Стубови потпорне конструкције	C 40/50, XC4, VI	B500B	5.0
Зидови потпорне конструкције	C 30/37, XC4, VI	B500B	5.0
Лежишне греде потп. конструкције	C 30/37, XC4, VI	B500B	5.0
Попречни носачи потп. конструкције	C 30/37, XC4, XD1, XF2, V-II	B500B	5.0
Шипови	C 30/37	B500B	9.0
Подбетон	C 12/15, X0		

MATERIAL PROPERTIES

Component	Concrete	Reinforcement	Clear cover
RC in retaining walls foundations	C 25/30, XC2, PVII	B500B	5.0
RC in retaining wals	C 25/30, XC4, XF1, PV-I	B500B	5.0
Edge beams and sidewalks	C 40/50, XC4, XD3, XF4, PV-II	B500B	4.5
Pile caps and ret. const. foundations	C 30/37	B500B	5.0
Piers of retaining construction	C 40/50, XC4, VI	B500B	5.0
Walls of retaining construction	C 30/37, XC4, VI	B500B	5.0
Bearing beams of retaining construction	C 30/37, XC4, VI	B500B	5.0
Cross girders of retaining construction	C 30/37, XC4, XD1, XF2, V-II	B500B	5.0
Piles	C 30/37	B500B	9.0
Lean concrete	C 12/15, X0		

Број/Number	Датум / Date	Опис / Description
03		
02		
01		

Ревизиони блок: / Revision block:

中国铁设 CRDC

China Railway Design Corporation Serbia
Ogranak Beograd
Косте Рацина 16б; 11000 Београд; Србија

Организациона јединица: ГРАЂЕВИНАРСТВО И САОБРАЋАЈ
Organization unit: DEPARTMENT OF CIVIL AND TRANSPORTATION

Одговорни пројектант:
Responsible designer:
Зоран Луковић, дипл.грађ.инж
лиценца број: / license No.: 310 3032 03

Сарадници: / Associates:

Инвеститор пројекта: / Investor:
" ИНФРАСТРУКТУРА ЖЕЛЕЗНИЦЕ СРБИЈЕ " А.Д.
/ " INFRASTRUCTURE RAILWAYS OF SERBIA " JSC
Немањина 6/IV, Београд / Nemanjina Street 6/IV, Belgrade

Наручилац пројекта: / Employer:
中国铁设咨询集团有限公司
CRDC RAILWAY INTERNATIONAL CO., LTD.
China Railway International Corporation Ltd.
No.10 Fuxing Road,Haidian District,Beijing
P.R.China, 100844

China Communication Construction Company Ltd. (CCCC)
No.85 Deshengmenwai Street,Xicheng District,Beijing
P.R.China, 100088

Објекат: /Structure:
ПРУГА БЕОГРАД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
ДЕОНИЦА ПРУГЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
BELGRADE - SUBOTICA - STATE BORDER (KELEBIA) RAILWAY LINE
SECTION : NOVI SAD - SUBOTICA - STATE BORDER (KELEBIA)

Део пројекта: / Part of Design:
ПРОЈЕКАТ КОНСТРУКЦИЈА / DESIGN OF CONSTRUCTION

2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377,03
2/1.1.3.2 Retaining walls adjacent to the gallery at km 78+377,03

Унутрашња контрола: / Internal control:
Hou Jieping. Master & Shi Wei. Bachelor

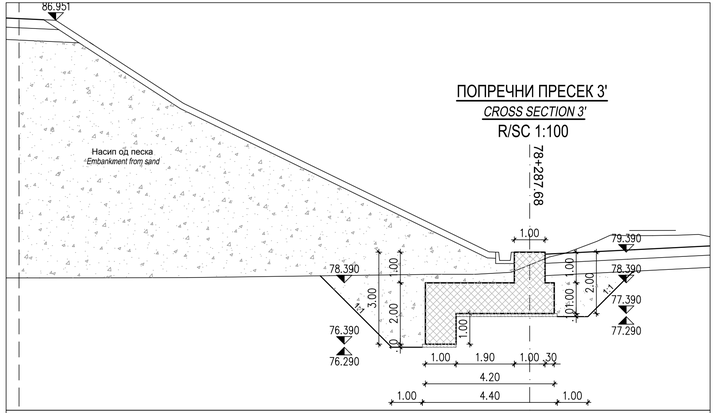
Главни пројектант: / Chief designer:
др Љиљана Милић Марковић, дипл.грађ.инж.

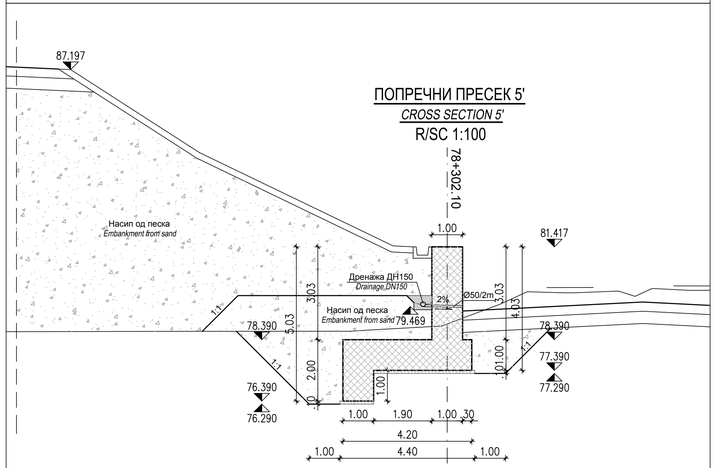
Руководилац организационе јединице:
Manager of organization unit:
др Љиљана Милић Марковић, дипл.грађ.инж.

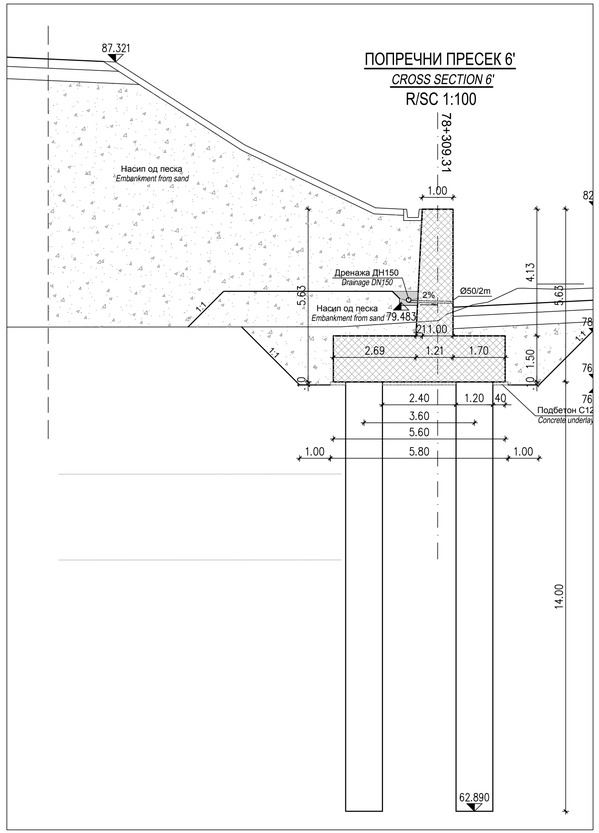
Цртеж: / Drawing:
ПОПРЕЧНИ ПРЕСЕК 3-3 И 4-4
CROSS SECTION 3-3 AND 4-4

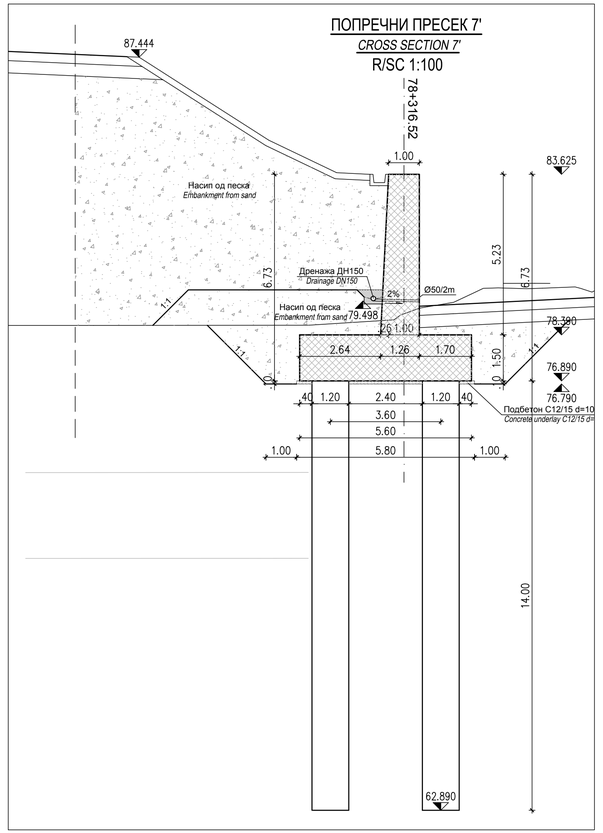
Размера: Scale: 1:100

Врста тех. док.: Type of tech. docum.:	датум/date:	Цртеж бр./Drawing No.:
ПГД / DCP	04.2021.	2020-001-ГС-2/1.1.3.2.7.Ц05.









КАРАКТЕРИСТИКЕ МАТЕРИЈАЛА:

Елемент	Бетон	Арматура	Заштитни слој
АБ темељи потпорних зидова	C 25/30, XC2, PVII	B500B	5.0
АБ потпорни зидови	C 25/30, XC4, XF1, PV-I	B500B	5.0
Ивични венци и пешачке стазе	C 40/50, XC4, XD3, XF4, PV-II	B500B	4.5
Наглавне греде и темељи потп. конс.	C 30/37	B500B	5.0
Стубови потпорне конструкције	C 40/50, XC4, VI	B500B	5.0
Зидови потпорне конструкције	C 30/37, XC4, VI	B500B	5.0
Лежишне греде потп. конструкције	C 30/37, XC4, VI	B500B	5.0
Попречни носачи потп. конструкције	C 30/37, XC4, XD1, XF2, V-II	B500B	5.0
Шипови	C 30/37	B500B	9.0
Подбетон	C 12/15, X0		

MATERIAL PROPERTIES

Component	Concrete	Reinforcement	Clear cover
RC in retaining walls foundations	C 25/30, XC2, PVII	B500B	5.0
RC in retaining walls	C 25/30, XC4, XF1, PV-I	B500B	5.0
Edge beams and sidewalks	C 40/50, XC4, XD3, XF4, PV-II	B500B	4.5
Pile caps and ret. const. foundations	C 30/37	B500B	5.0
Piers of retaining construction	C 40/50, XC4, VI	B500B	5.0
Walls of retaining construction	C 30/37, XC4, VI	B500B	5.0
Bearing beams of retaining construction	C 30/37, XC4, VI	B500B	5.0
Cross girders of retaining construction	C 30/37, XC4, XD1, XF2, V-II	B500B	5.0
Piles	C 30/37	B500B	9.0
Lean concrete	C 12/15, X0		

Број/Number	Датум / Date	Опис / Description
03		
02		
01		

Ревизиони блок: / Revision block:

China Railway Design Corporation Serbia Ogranak Beograd
Косте Рацина 16б; 11000 Београд; Србија

Организациона јединица: ГРАЂЕВИНАРСТВО И САОБРАЋАЈ
Organization unit: DEPARTMENT OF CIVIL AND TRANSPORTATION

Одговорни пројектант:
Responsible designer:
Зоран Луковић, дипл.грађ.инж
лиценца број:/ license No.: 310 3032 03

Сарадници: / Associates:

Инвеститор пројекта: / Investor:
" ИНФРАСТРУКТУРА ЖЕЛЕЗНИЦЕ СРБИЈЕ " А.Д.
/ " INFRASTRUCTURE RAILWAYS OF SERBIA " JSC
Немањина 6/В, Београд / Nemanjina Street 6/B, Belgrade

Наручилац пројекта: / Employer:
China Railway International Corporation Ltd, No.10 Fuxing Road,Haidian District,Beijing P.R China, 100844
China Communication Construction Company Ltd, (CCCC) No.85 Deshengmenwai Street,Xicheng District,Beijing P.R China, 100088

Објекат: /Structure:
ПРУГА БЕОГРАД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
ДЕОНИЦА ПРУТЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
BELGRADE - SUBOTICA - STATE BORDER (KELEBIA) RAILWAY LINE
SECTION : NOVI SAD - SUBOTICA - STATE BORDER (KELEBIA)

Део пројекта: / Part of Design:
ПРОЈЕКАТ КОНСТРУКЦИЈА / DESIGN OF CONSTRUCTION

2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03
2/1.1.3.2 Retaining walls adjacent to the gallery at km 78+377.03

Унутрашња контрола: / Internal control:
Hou Jieping. Master & Shi Wei. Bachelor

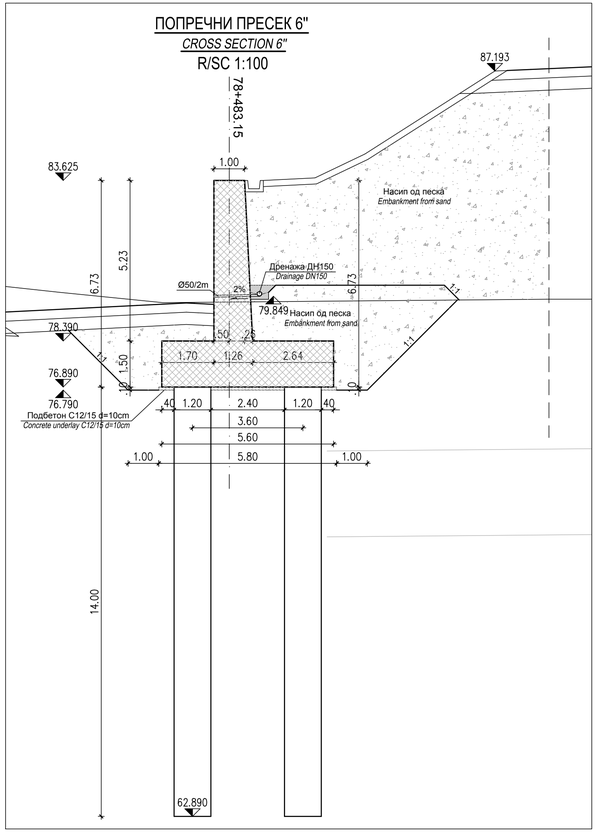
Главни пројектант: / Chief designer:
др Љиљана Милић Марковић, дипл.грађ.инж.

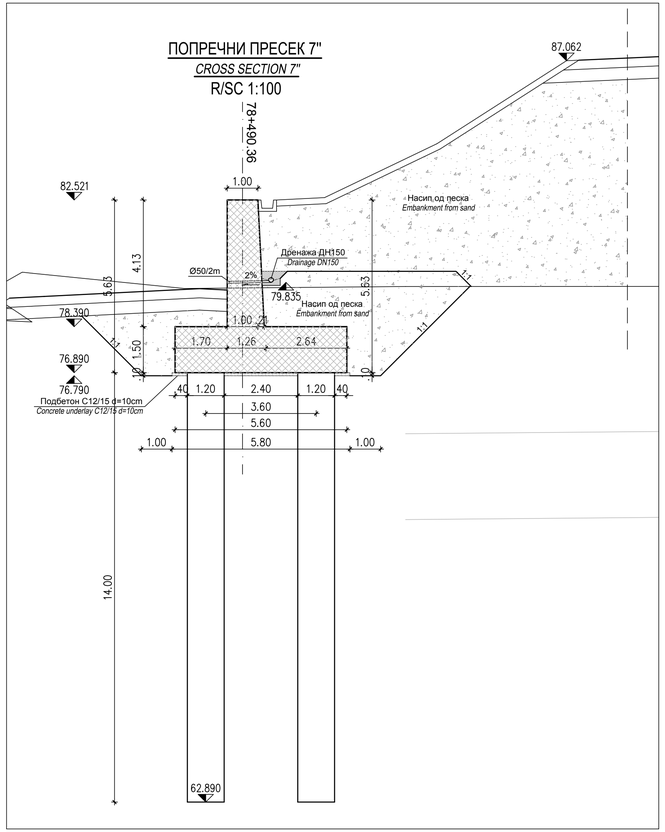
Руководилац организационе јединице:
Manager of organization unit
др Љиљана Милић Марковић, дипл.грађ.инж.

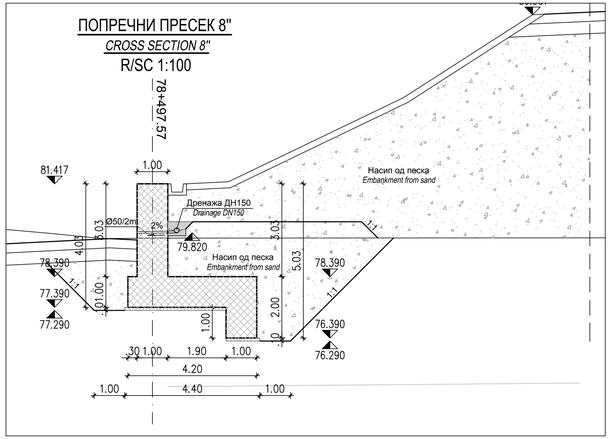
Цртеж: / Drawing:
ПОПРЕЧНИ ПРЕСЕК 3', 5', 6', 7'
CROSS SECTION 3', 5', 6', 7'

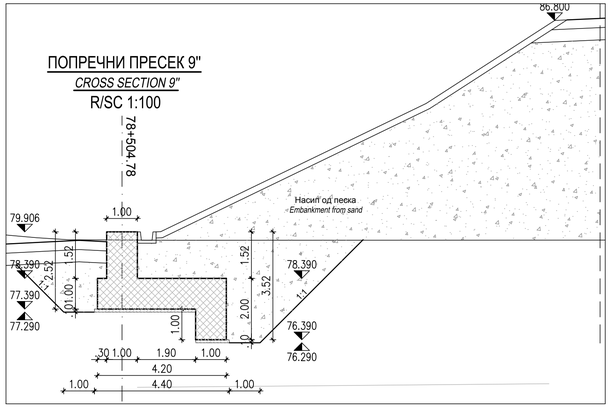
Размера: Scale: 1:100

Врста тех. док.: Type of tech. docum.: ПГД / DCP
датум/date: 04.2021.
Цртеж бр. /Drawing No.: 2020-001-ГС-2/1.1.3.2.7.ЦЈ06.









КАРАКТЕРИСТИКЕ МАТЕРИЈАЛА:

Елемент	Бетон	Арматура	Заштитни слој
АБ темељи потпорних зидова	С 25/30, XC2, PVII	B500B	5.0
АБ потпорни зидови	С 25/30, XC4, XF1, PV-I	B500B	5.0
Ивични венци и пешачке стазе	С 40/50, XC4, XD3, XF4, PV-II	B500B	4.5
Наглавне греде и темељи потп. конс.	С 30/37	B500B	5.0
Стубови потпорне конструкције	С 40/50, XC4, VI	B500B	5.0
Зидови потпорне конструкције	С 30/37, XC4, VI	B500B	5.0
Лежишне греде потп. конструкције	С 30/37, XC4, VI	B500B	5.0
Попречни носачи потп. конструкције	С 30/37, XC4, XD1, XF2, V-II	B500B	5.0
Шипови	С 30/37	B500B	9.0
Подбетон	С 12/15, X0		

MATERIAL PROPERTIES

Component	Concrete	Reinforcement	Clear cover
RC in retaining walls foundations	C 25/30, XC2, PVII	B500B	5.0
RC in retaining wals	C 25/30, XC4, XF1, PV-I	B500B	5.0
Edge beams and sidewalks	C 40/50, XC4, XD3, XF4, PV-II	B500B	4.5
Pile caps and ret. const. foundations	C 30/37	B500B	5.0
Piers of retaining construction	C 40/50, XC4, VI	B500B	5.0
Walls of retaining construction	C 30/37, XC4, VI	B500B	5.0
Bearing beams of retaining construction	C 30/37, XC4, VI	B500B	5.0
Cross girders of retaining construction	C 30/37, XC4, XD1, XF2, V-II	B500B	5.0
Piles	C 30/37	B500B	9.0
Lean concrete	C 12/15, X0		

Број/Number	Датум / Date	Опис / Description
03		
02		
01		

Ревизиони блок: / Revision block:

China Railway Design Corporation Serbia
Ogranak Beograd
Косте Рацина 16б; 11000 Београд; Србија

Организациона јединица: ГРАЂЕВИНАРСТВО И САОБРАЋАЈ
Organization unit: DEPARTMENT OF CIVIL AND TRANSPORTATION

Одговорни пројектант:
Responsible designer:
Зоран Луковић, дипл.грађ.инж
лиценца број:/ license No.: 310 3032 03

Сарадници: / Associates:

Инвеститор пројекта: / Investor:
" ИНФРАСТРУКТУРА ЖЕЛЕЗНИЦЕ СРБИЈЕ " А.Д.
/ " INFRASTRUCTURE RAILWAYS OF SERBIA " JSC
Немањина 6/В, Београд / Nemanjina Street 6/B, Belgrade

Наручилац пројекта: / Employer:
China Railway International Corporation Ltd, No.15 Fuxing Road,Haidian District,Beijing P.R China, 100844
China Communication Construction Company Ltd, (CCCC) No.85 Deshengmenwai Street,Xicheng District,Beijing P.R China, 100088

Објекат: /Structure:
ПРУГА БЕОГРАД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
ДЕОНИЦА ПРУТЕ НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
BELGRADE - SUBOTICA - STATE BORDER (KELEBIA) RAILWAY LINE
SECTION : NOVI SAD - SUBOTICA - STATE BORDER (KELEBIA)

Део пројекта: / Part of Design:
ПРОЈЕКАТ КОНСТРУКЦИЈА / DESIGN OF CONSTRUCTION

2/1.1.3.2 Пројекат потпорних зидова уз галерију на км 78+377.03
2/1.1.3.2 Retaining walls adjacent to the gallery at km 78+377.03

Унутрашња контрола: / Internal control:
Hou Jieping. Master & Shi Wei. Bachelor

Главни пројектант: / Chief designer:
др Љиљана Милић Марковић, дипл.грађ.инж.

Руководилац организационе јединице:
Manager of organization unit
др Љиљана Милић Марковић, дипл.грађ.инж.

Цртеж: / Drawing:
ПОПРЕЧНИ ПРЕСЕК 6", 7", 8", 9"
CROSS SECTION 6", 7", 8", 9"

Размера: Scale: 1:100

Врста тех. док.: Type of tech. docum.: ПГД / DCP

датум/date: 04.2021.

Цртеж бр./Drawing No.: 2020-001-ГС-2/1.1.3.2.7.ЦЈ07.